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ATLAS OF SEABIRD DISTRIBUTION AND RELATIVE ABUNDANCE IN THE EASTERN TROPICAL PACIFIC

by

Robert L. Pitman

ADMINISTRATIVE REPORT LJ-86-02C

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AND RELATIVE ABUNDANCE IN THE
EASTERN TROPICAL PACIFIC

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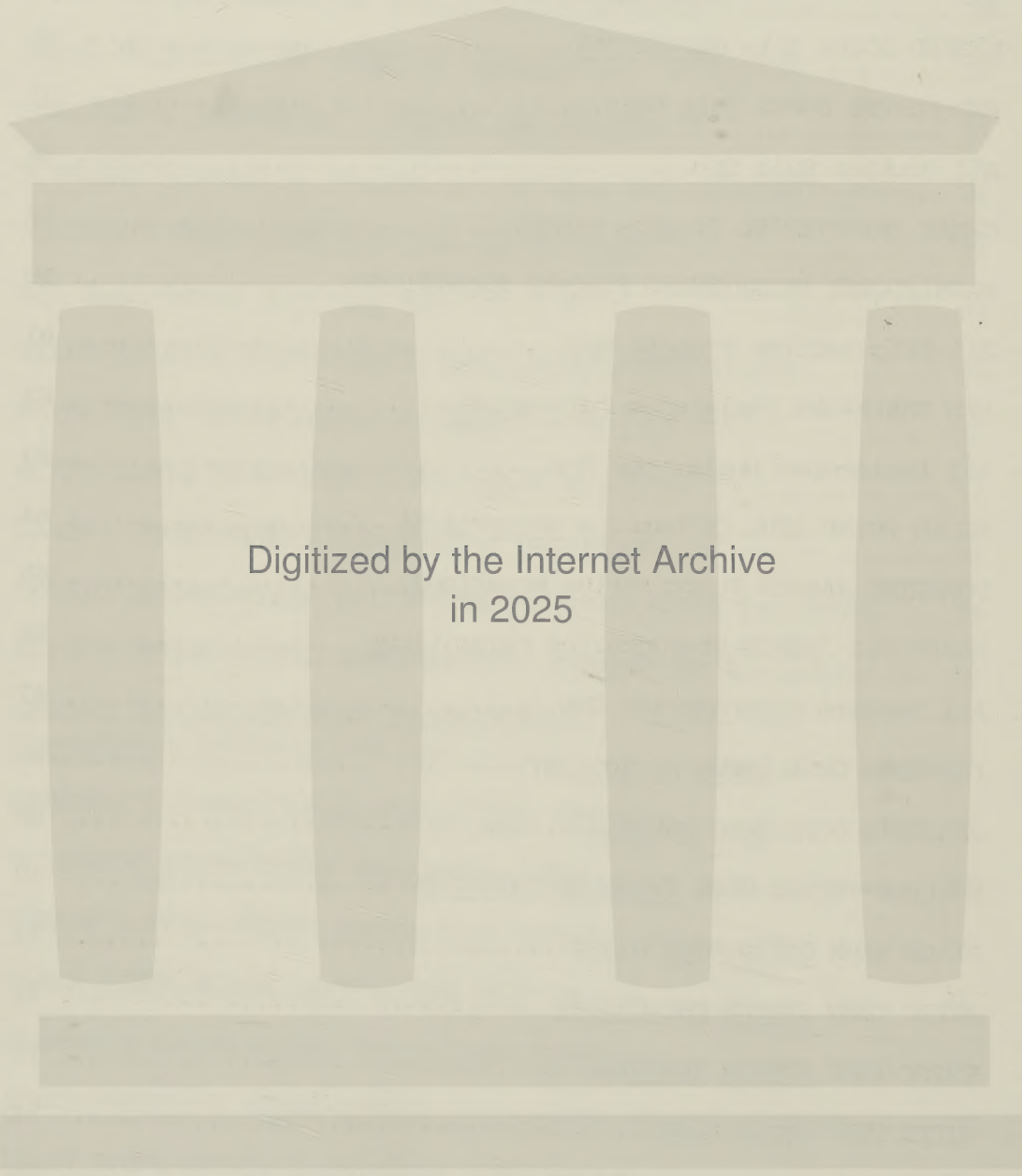
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ABSTRACT

In this report I summarize the results of 4333 hours of marine bird observations which I made in the eastern tropical Pacific (ETP) from 1974 to 1984. The study area included most of ETP from lat. 30° N to lat. 20° S, and east of long. 160° W, to the Americas. During this survey, 263,122 individual marine birds of 120 species were recorded. Sighting data are presented in a series of 77 maps showing the distribution and relative abundance of the 59 most commonly encountered species and species groups; information on less common birds is included in an Appendix. A brief text discusses methods of data collection and analysis, and provides an overview of the results of this study.

INTRODUCTION

The study of seabird ecology has traditionally been one-sided. Man, the terrestrial investigator, has always found it more convenient and economical to study marine birds where they come ashore to breed. Consequently, most knowledge about marine birds relates to the time they are land-based (Brown 1980). Although there have been a few, large-scale, systematic studies of the pelagic distribution of marine birds (e.g. King 1970, Brown et al. 1975b, Gould et al. 1982), information on this subject has been accumulated through a slow and varied process. This has included reported sightings from individual cruises (e.g. Hamilton 1958, Peakall 1960), longer term studies from relatively small areas (e.g. Vooren 1972), individually published sighting records (e.g. Macdonald 1952, Binford 1970), stranding reports (e.g. Imber 1971, Cooper 1978), and early museum expeditions (e.g. Murphy 1924, Fisher and Wetmore 1931).

Murphy (1936) pointed out early on that seabirds are not

randomly scattered over the ocean as might appear to be the case; instead they recognize and respond to different habitats. This has been demonstrated more often and more clearly for near-shore species than for off-shore species (e.g. Brown et al. 1975a, Ainley 1976). Recent studies, however, on the habitats of seabirds on the open ocean have suggested that pelagic species may also be sensitive to fine scale gradations in their marine environment (Pocklington 1979).

Mapping distributions is the first step in understanding the physical and biological factors that control marine bird occurrences. This information can also help elucidate their role in marine food webs. For example, the pelagic ecology of tropical seabirds is closely linked with that of commercially valuable tunas (Ashmole 1971); an understanding of where birds are can provide insight into the distribution and biology of the tuna (Au and Pitman MS). Mapping seabird distributions is also useful for determining areas of significant biological importance. This becomes more important with the increasing exploitation of ocean resources.

STUDY AREA AND METHODS

Study Area

For the purposes of this Atlas I defined the eastern tropical Pacific (ETP) as the area south of the tip of Baja California, Mexico, (23° N), north of 15° S, and east of 140° W to the Americas. This encompasses an ocean area of approximately 14 million km^2 . The bulk of the survey results reported here were collected within that area and only those species recorded from within it are included in the Atlas. For those species whose ranges extend beyond this area, results from additional, less extensive surveys in adjacent waters are also presented. The area covered by the species distribution plots has been extended to include the area from 30° N to 20° S and from the Americas out to 160° W (Figure 1). This has the effect of showing more fully the geographic ranges of species that occur in the ETP while precluding many colder water species (e.g. alcids off Baja California). This larger area encompasses approximately 24 million km^2 of ocean surface and will be referred to as the study area.

A basic review is provided here to acquaint the reader with some of the major aspects of ETP oceanography. The following synopsis derives mainly from the works of Wyrteki (1966, 1967, 1974) and Cromwell (1958).

The circulation of surface waters in the ETP is dominated by zonal (east/west) currents (Figure 2) that are ultimately driven by the trade winds. In the eastern Pacific, the southward-flowing California Current turns west and continues as part of the North Equatorial Current (NEC), while the north-flowing Peru Current veers west to become part of the South Equatorial Current (SEC) flowing strongly along the equator. Sandwiched between

these westerly currents, the narrow Equatorial Countercurrent (ECC) flows to the east. Directly on the equator, the Equatorial Undercurrent (EUC, also called the Cromwell Current) flows east as a subsurface current below the SEC and surfaces just west of the Galapagos. Because of the configuration of the ocean, the anticyclonic circulation of the north and south Pacific does not penetrate into the area between Cabo Corrientes, Mexico, and Ecuador, and circulation there is complicated and less well defined.

Zonal flow of the equatorial currents is partially developed at long. 125° W and well established by long. 140° W. The boundaries of the major surface currents are: NEC, lat. $8-10^{\circ}$ N to lat. 20° N; ECC, lat. $3-5^{\circ}$ N to lat. $9-10^{\circ}$ N; SEC, lat. $3-5^{\circ}$ N to lat. $9-10^{\circ}$ S.

Wyrtki (1967) divided the ETP into three distinct zones based on temperature/salinity characteristics (Figure 3). His Tropical Surface Water is an area of low salinity, usually $<34^{\circ}/\text{oo}$ due to an excess of rainfall over evaporation, and high temperature ($>25^{\circ}\text{C}$). South of the Tropical Surface Water lies a band of Equatorial Surface Water characterized by slightly higher salinity ($34^{\circ}/\text{oo}-35^{\circ}/\text{oo}$) and variable but generally cooler temperatures due to advection of the Peru Current and equatorial upwelling. Contiguous to these water masses lie the North and South Subtropical Surface Waters, which generally have lower temperatures ($28^{\circ}-15^{\circ}\text{C}$) and higher salinities ($>35^{\circ}/\text{oo}$).

Divergences and convergences, which are associated with zonal surface flow in the ETP, result in troughs and ridges in the thermocline topography, and these have a strong influence on surface productivity. Along the equator and lat. 10° N, divergent current flows raise the thermocline closer to the surface and account for increased productivity. A convergence associated with the southern boundary of the ECC and northern limit of the SEC depresses the thermocline, but may cause enhanced biological activity by concentrating organisms at the surface there.

Data Collection

Between December 1974 and May 1984 I made 18 cruises within the study area (Table 1). A breakdown of observation time by month is given in Figure 4. Areal distribution of the survey coverage is shown in Figure 5 where the number of noon positions occupied per 2° sq. is plotted.

My seabird sighting methods were adapted from sighting methods used for surveying marine mammals (see Holt and Powers 1982). I made observations from sunup to sundown, generally during 2-3 hour watches separated by half hour rest periods. During cruises #2 and #3, I used 20 x 120 mm USN MK-3 mounted spotting binoculars; for cruises #5-18 I used 25 x 150 mm Fuji mounted spotting binoculars. The glasses were mounted port and starboard on the flying bridge. Depending on the vessel, my eye

level was 10-15 m above the water and sighting distance to the horizon approximately 13-16.5 km (7-9 nautical miles). The field of view from the freely rotating, mounted binoculars was usually greater than 270° and always included 180° of viewing arc across the bow of the ship. For cruises #1 and #4, I used hand-held 8 power binoculars and data from these cruises are treated separately (see below).

All birds were identified to the lowest possible taxon and recorded regardless of distance from the ship. Additional information noted included behavior, plumage, direction of travel, associations, and noteworthy environmental factors. Ship speed, sea conditions (Beaufort Scale) and overall observation conditions (Table 2) were recorded hourly. The categories in Table 2 became more subjective when dealing with parameters other than those outlined above. Other factors taken into account in determining observation conditions included glare (amount and location), the effects of ship vibration on the deck-mounted binoculars, stack gas from the vessel distorting the field of view, and observer fatigue.

Data Analysis

Plots of bird distributions were generated from computer programs developed at the Southwest Fisheries Center for plotting dolphin distributions and abundance (see Perrin et al. 1983). These were modified for use with bird data collected during this study. Sighting data for bird species seen on 10 or more days were plotted; species seen on fewer than 10 days were considered rare and listed with pertinent data in the Appendix.

As used in the Atlas, relative abundance refers only to intraspecific comparisons of abundance. Using mounted, high-powered binoculars and counting all birds seen, regardless of distance from the ship, allowed me to collect the greatest amount of data during a given time period, but it also magnified detectability biases for different species groups. These biases are based on differences in size, foraging behavior, ship avoidance, etc. It is of course desirable to be able to make direct comparisons of abundance between different species by using the same set of intervals for the legends in the species plots, but the biases referred to above would have caused such comparisons to be misleading. For example, frigatebirds, large, soaring species, were routinely sighted 11-15 km (6-8 nautical miles) away. Storm-petrels, on the other hand, are tiny and hover close to the water; they were rarely seen over 1.8 km (1 nautical mile) away. Though storm-petrels are considerably more abundant than frigatebirds, detectability biases have undoubtedly made their overall numbers seem more comparable.

Relative abundance was determined for all species on days when an Observation Condition of 3, 4, 5 or 6 was recorded (see Table 2). On days when an Observation Condition 1, 2 or 7 was recorded, all species were excluded from relative abundance analyses; on days when Observation Condition 8 was recorded, only

small and low-flying species were excluded. These included storm-petrels, phalaropes, noddy terns and small shearwaters (e.g. Newell's and Audubon's Shearwaters). Data collected on days with fewer than two hours of observation time or from a vessel whose speed averaged less than five kts. were not used for analyses of relative abundance.

For purposes of the species plots, if the criteria outlined above were not met on a given day, individual species sighted were listed only as present (i.e., "+" in the species plots and Appendix), with no indication of relative abundance. On cruises #1 and #4 only handheld binoculars were used, and the data were used to indicate only where species were present also. Questionable sightings, especially for difficult to identify species (e.g. Stejneger's Petrel, Harcourt's Storm-Petrel), are shown as "possibly present" (i.e. "?") in the species plots and Appendix.

Individual plots are presented for most of the species that regularly occur in the ETP. The only exceptions are those species (or subspecies) that were difficult to separate in the field and whose ranges overlap (e.g. Juan Fernandez/White-necked Petrels, Townsend's/Newell's Shearwaters). For these, a plot is presented for positive identifications of each species as well as a pooled plot that includes all identified as well as unidentified members of the pair. Data for color morphs of Wedge-tailed Shearwater and Leach's Storm-Petrel were plotted in the same way. Cumulative plots (e.g. all boobies, all jaegers) also include all identified, as well as unidentified, members of the group.

Plotting Methods

A 2° square was used as the basic plot unit for the following reasons. Approximately 120 km (65 nautical miles) of ocean was surveyed per day during the study. Survey effort was not continuous, however, but was usually spread out over a 10-12 hr. day so that survey results for a single day could represent over 240 km (130 nautical miles) of surveyed ocean. Given that a 1° square in low latitudes is approximately 110 km (60 nautical miles) on a side, a 2° square was felt to be an appropriate scale for presenting sighting data.

Daily vessel positions at noon were assigned to the nearest center of a 2° square (Figure 6). For days when minimum criteria were met (see Data Analysis), daily survey results (number of birds, by species, and number of survey hours) were assigned to each of the four 1° squares that make up a 2° square. Whenever the results for the same or adjacent 2° squares overlapped, the results were pooled (total birds/total hours) for the affected 1° square(s) (Figure 6). This method of plotting has the advantage of providing contouring where 2° squares overlap, but it can also average out high and low values for a given area, masking, for example, seasonal variation in occurrence.

To determine the interval size for the four relative

abundance categories shown in the legends of the species plots, I devised a method to provide standard percentile intervals for each of the species results. To do this, I used a computer to generate a table listing the birds/hour results from each 1° square, from least to most abundant; I excluded squares with effort but no sightings. For a square having more than one value assigned to it, I used only the pooled result (see Figure 6). Starting with the lowest values, I included half the total number of values in the table in the interval of least abundance and I used the highest value in the group as the cut-off for the interval. Half of the remaining values went into the next higher abundance interval, half in the next, and so on. Using this method, I apportioned approximately 94% ($1/2 + 1/4 + 1/8 + 1/16$) of the values listed in each table into the four available intervals. The remaining 6% of the values were used to smooth out the interval breaks (e.g. the interval 1-5 birds/hour was preferred over 1-3.6 birds/hour).

This "halving method" was used only as a general guideline for standardizing the distribution of values shown in the legends of the individual species plots. In practice, it worked quite well but as expected there was some deviation from the optimal scheme.

RESULTS

Maps 1-77 show the distribution and relative abundance of the 59 most common species of marine birds encountered in the eastern tropical Pacific during this study. An additional 25 infrequently sighted species are included in the Appendix. A complete discussion of findings is beyond the scope of the present report but some general comments can be made.

Map 1 shows a plot of all seabirds sighted. As expected, major areas of concentration were found along continental coastlines and near islands (mainly Clipperton, Cocos and Tuamotu Archipelago). Most of the open ocean concentrations were on or south of the equator and were a direct result of Sooty Tern abundance (compare Map 73). The only other offshore concentration was a small area near 10° N 122° W where Wedge-tailed Shearwaters and Juan Fernandez Petrels were dominant.

In general, major avifaunal assemblages were associated with four geographical areas:

- 1) Nearshore - e.g. dark-rumped Leach's Storm-Petrel (Map 40), Black Storm-Petrel (45), Least Storm-Petrel (48), Sabine's Gull (69), Black Tern (71).

- 2) Peru Current/Galapagos - e.g. Waved Albatross (Map 2), Markham's Storm-Petrel (46), Swallow-tailed Gull (70).

- 3) Inner ETP - e.g. light morph Wedge-tailed Shearwater (Map 25), Brown Booby (54), Masked Booby (56), Red-footed Booby (57), Pomarine Jaeger (65).

4) Outer ETP - e.g. all Pterodroma (Maps 6-20), dark morph Wedge-tailed Shearwater (26), Red-tailed Tropicbird (51), White-tailed Tropicbird (52), possibly Parasitic Jaeger (66), Sooty Tern (73), White Tern (74).

The species composition of the Nearshore and Peru Current/Galapagos avifauna are fairly well known from earlier works (e.g. Murphy 1936). The Inner ETP area lies roughly north of the equator and east of 110° W, and corresponds to Tropical Surface Water east of Clipperton Island (Figure 3). This is an area of high productivity and also a major commercial fishing ground for surface-caught yellowfin tuna. Tuna is very important in the feeding ecology of birds in this area and flocks are often found feeding on prey driven to the surface by foraging tunas (Au and Pitman MS).

Zonal current flow starts to develop between 110° W and 125° W in the eastern tropical Pacific. Marine bird distribution in the Outer ETP area was correspondingly zonal and showed distinct habitat preferences by several species. Juan Fernandez/White-necked Petrels (Map 11), Black-winged Petrel (15), dark morph Wedge-tailed Shearwater (26), probably Newell's Shearwater (30), and Red-tailed Tropicbird (51) were closely associated with the southern edge of the North Equatorial Current at 10° N. Away from breeding colonies in the Society Islands, Tahiti Petrel (12) was widespread but most abundant within the Equatorial Countercurrent. Herald Petrel (6), White-throated Storm-Petrel (35), possibly Parasitic Jaeger (66), Sooty Tern (73), and White Tern (74) were most common within the South Equatorial Current.

These results suggest that even within the relatively unproductive, open waters of the tropical Pacific, marine birds identify and respond to different habitats that are largely defined by zonal circulation patterns. It is also evident from the plots that upwelling associated with the equator is of only minor importance to seabirds (at least on the equator), while upwelling (thermocline "ridging") associated with current divergence at 10° N is of major importance. Subsequent analyses of these data will deal with these and other findings in more detail.

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Table 1. SUMMARY OF SEABIRD SURVEY CRUISES, OBSERVATION EFFORT AND SIGHTING DATA COLLECTED IN THE EASTERN TROPICAL PACIFIC OCEAN BY THE AUTHOR.

CRUISE NO.	CRUISE DATES	VESSEL	ITINERARY SURVEY	AVERAGE SPEED (KTS)	# OF DAYS AT SEA IN SURVEY AREA	TOTAL HR. OF OBSERVATION	AVE. HRS PER DAY	TOTAL MILES SENSORED	# OF SPECIES SEEN	# OF INDIVIDUAL BIRDS SEEN
1	13 Nov 1974 - 2 Jan 1975	Hero	Long Beach, California (Ca); Manzanillo, Mexico; Ushuaia, Argentina	9.2	22	148.75	6.56	1327.50	32	2637
2	5 Jan - 2 Mar, 1976	David Starr Jordan	San Diego, Ca; San Cristobal, Galapagos Islands; Cocos Island (Costa Rica); Puntarenas, Costa Rica; San Diego, Ca.	10.00	51	416.50	8.17	4165.00	61	27493
3	4 Jan - 8 Mar, 1977	David Starr Jordan	San Diego, Ca; Lima, Peru; San Diego, Ca.	9.41	56	584.75	10.26	5406.10	62	22549
4	8 Apr - 18 April, 1978	Sea World	Puerto Vallarta, Mexico; Socorro Island, San Benedicto Island, Revillagigidos Islands, Mexico; Cabo San Lucas, Baja California, Mexico.	9.00	4	15.00	3.75	135.00	26	1095
5	3 Jan - 10 Mar, 1979	David Starr Jordan	San Diego, Ca; Cocos Island (Costa Rica); Puntarenas, Costa Rica; Acapulco, Mexico; Manzanillo, Mexico; San Diego, Ca.	9.96	53	519.75	8.96	5174.20	49	27861
6	27 Sept - 24 Oct, 1979	David Starr Jordan	San Diego, Ca; San Diego, Ca.	10.12	8	65.00	8.13	657.65	24	5625
7	3 Jan - 5 Mar, 1980	David Starr Jordan	San Diego, Ca; Canal Zone, Panama; Manzanillo, Mexico; San Diego, Ca.	10.26	54	406.00	7.52	4165.18	54	13710
8	21 Mar - 19 Apr, 1980	Oceanographer	San Diego, Ca; Kwajalein, Marshall Islands.	13.83	22	136.50	6.10	1856.28	40	14558
9	17 June - 11 July, 1980	David Starr Jordan	San Diego, Ca; San Diego, Ca.	9.70	3	20.50	6.83	198.80	26	2786
10	21 July - 25 Sept, 1980	Researcher	Miami, Florida (FL); Canal Zone, Panama; Manzanillo, Mexico; Canal Zone, Panama; Miami, FL.	12.88	45	169.75	3.69	2138.88	46	9887
11	20 Jan - 31 Mar, 1981	Oceanographer	Seattle, Washington (WA); San Diego, Ca; Acapulco, Mexico; San Diego, Ca; Seattle, WA.	12.65	48	196.50	4.00	2429.40	43	8651
12	19 May - 23 June, 1981	Oceanographer	Seattle, WA; San Diego, Ca; Canal Zone, Panama; Seattle, WA.	13.78	54	293.25	5.43	4041.13	64	18281
13	14 Oct - 15 Dec, 1981	Researcher	Miami, FL; Canal Zone, Panama; Lima, Peru; Canal Zone, Panama; Miami, FL	12.47	44	194.50	4.40	2413.05	64	19025
14	19 Feb - 28 Apr, 1982	Discoverer	San Diego, Ca; Lima, Peru; Baltra, Galapagos Islands; Honolulu, Hawaii (HI).	13.18	61	265.25	4.33	3480.30	76	20758
15	10 May - 29 July, 1982	David Starr Jordan	San Diego, Ca; Manzanillo, Mexico; Honolulu, HI; San Diego, Ca.	10.01	73	328.25	4.50	3284.35	61	18893
16	10 Jan - 13 Apr, 1983	David Starr Jordan	San Diego, Ca; Cocos Island (Costa Rica); Lima, Peru; Papete, Tahiti; San Diego, Ca.	10.03	81	301.25	3.71	3016.82	83	33403
17	7 Oct - 6 Dec, 1983	Discoverer	Seattle, WA; Manzanillo, Mexico; Seattle, WA.	13.49	48	191.50	3.99	2583.32	57	7489
18	14 Feb - 7 May, 1984	Discoverer	Seattle, WA; Honolulu, HI; Papete, Tahiti; Pago Pago, American Samoa; Honolulu, HI; Seattle, WA.	14.28	19	80.50	4.20	1139.15	38	8421
ALL CRUISES				11.06	751	4333.50	5.73	47612.11	120	263122

Table 2. Observation Condition Codes

- 1 - bad; fog, rain or heavy seas (Beaufort 6+). Inability to use 25x binoculars precludes systematic observations.
- 2 - poor; moderately heavy seas (Beaufort 5-6). Wind buffeting binoculars and considerable pitching and rolling; occasional spray over the flying bridge; marginal conditions.
- 3 - fair; moderate seas (Beaufort 4-5). Many white-caps but mounted binoculars are stable with slight wind buffeting.
- 4 - good; light seas (Beaufort 3-4). White-caps fairly common but wind not a factor.
- 5 - very good; ripples on the water with occasional white-caps (Beaufort 2-3). Probably very few birds missed.
- 6 - excellent; flat calm (Beaufort 0-1). Ideal conditions.
- 7 - conditions other or unknown.
- 8 - fair/poor; only large or high-flying bird species are considered adequately sampled; conditions intermediate between Codes 1 and 2.

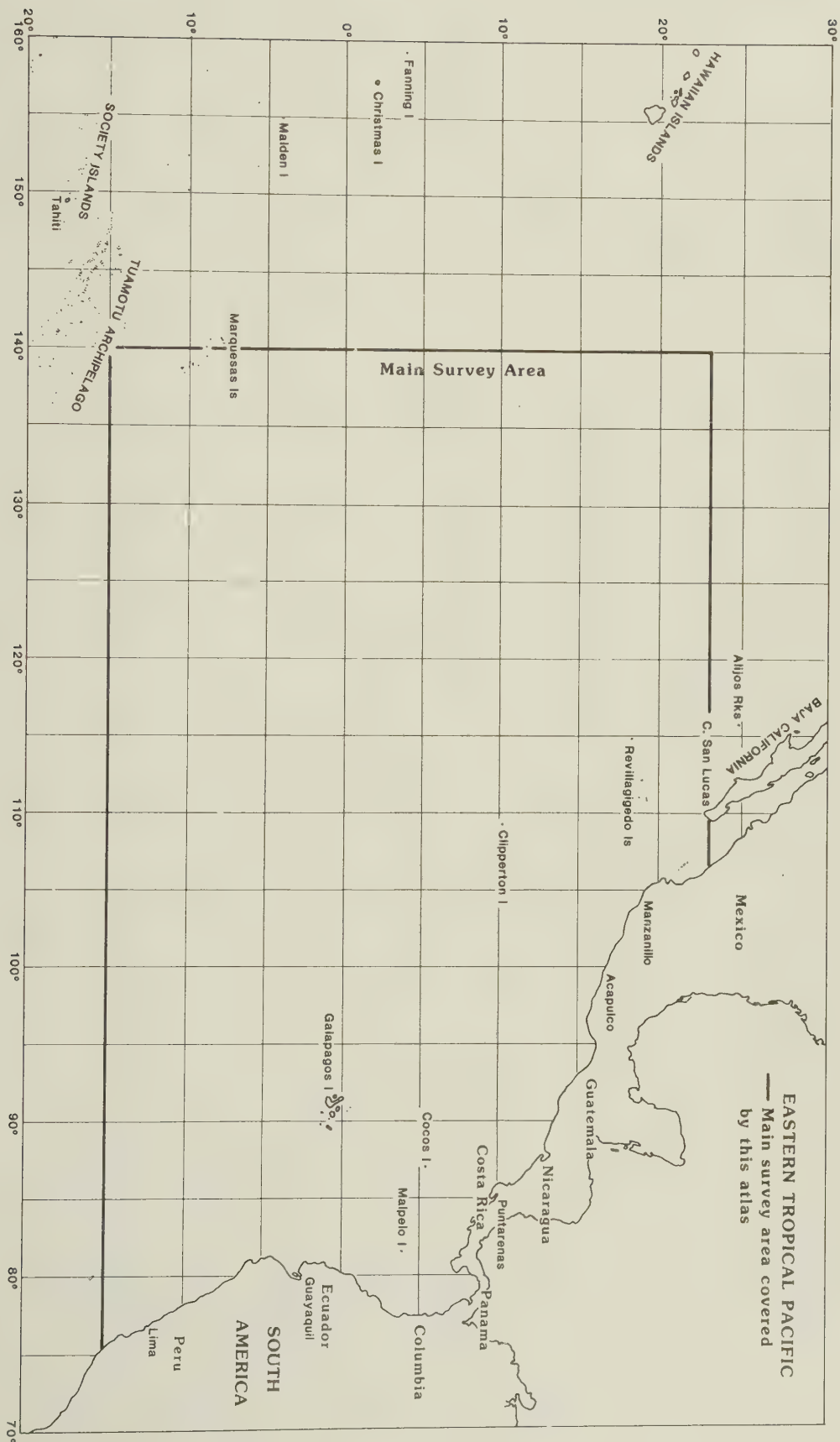


Figure 1. Map of survey area.

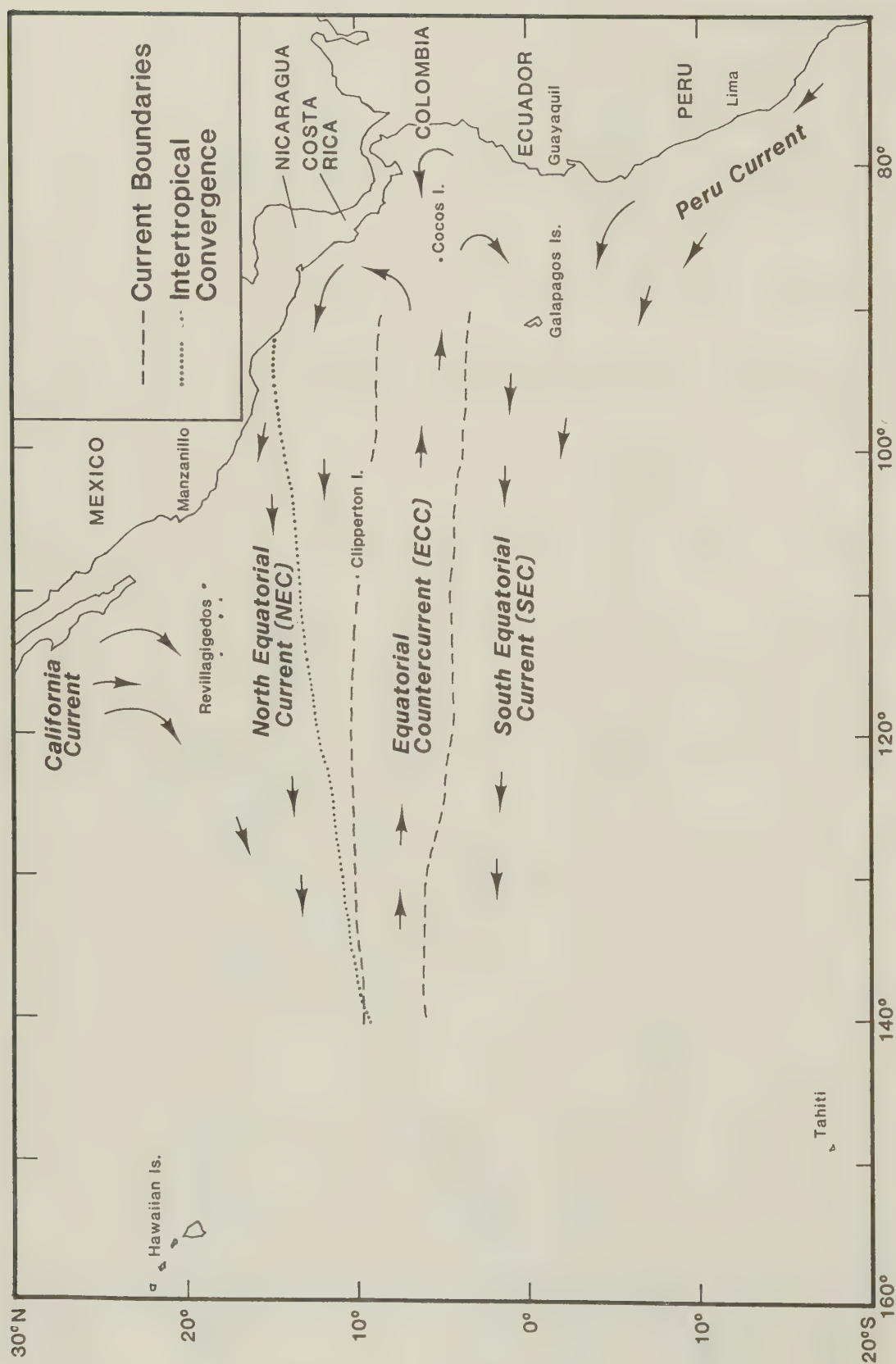


Figure 2. Major surface current flow in the eastern tropical Pacific Ocean during the month of August (from Wyrski 1965).

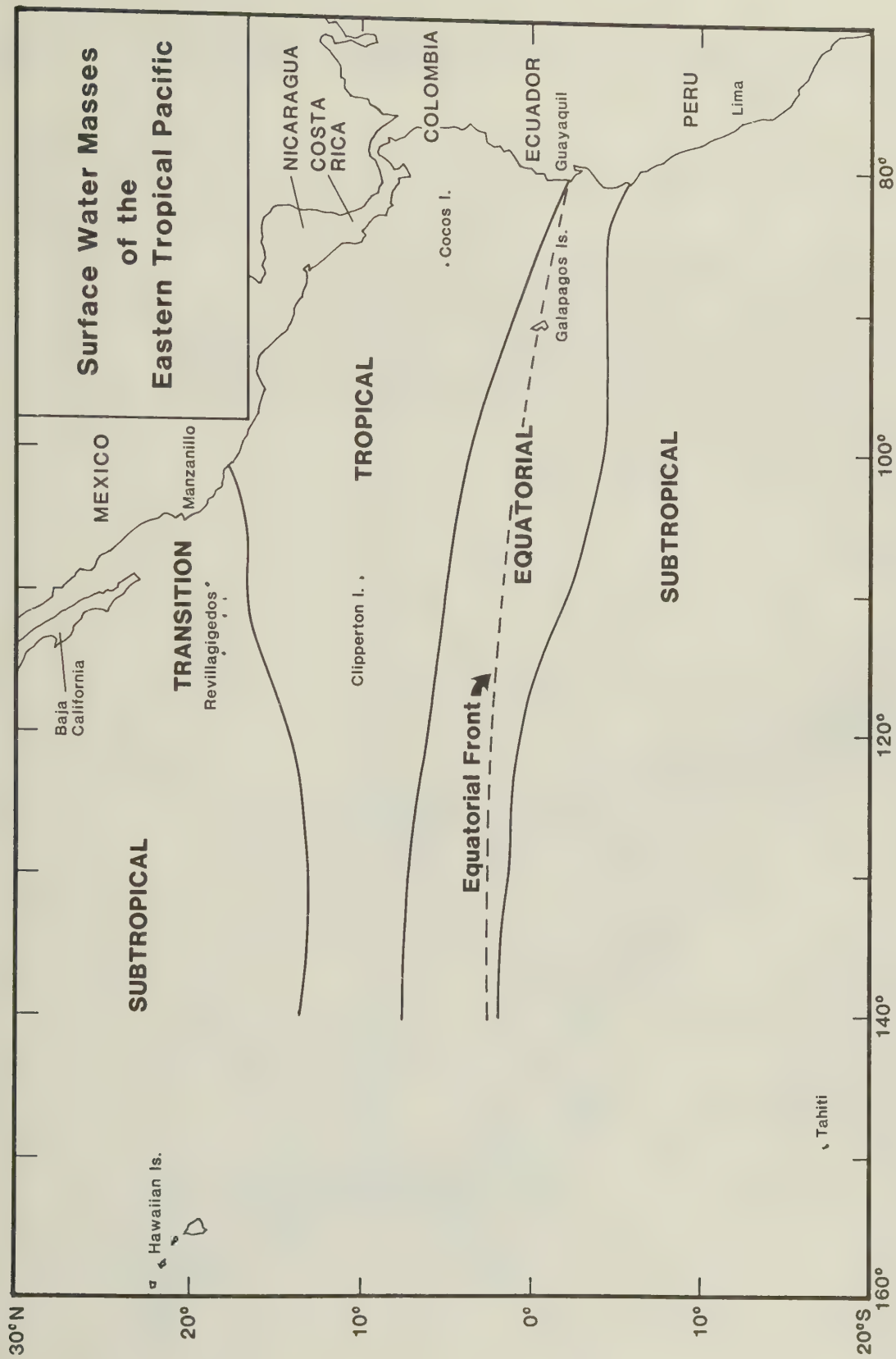


Figure 3. Generalized distribution of water masses in the eastern tropical Pacific (from Wyrtki 1967).

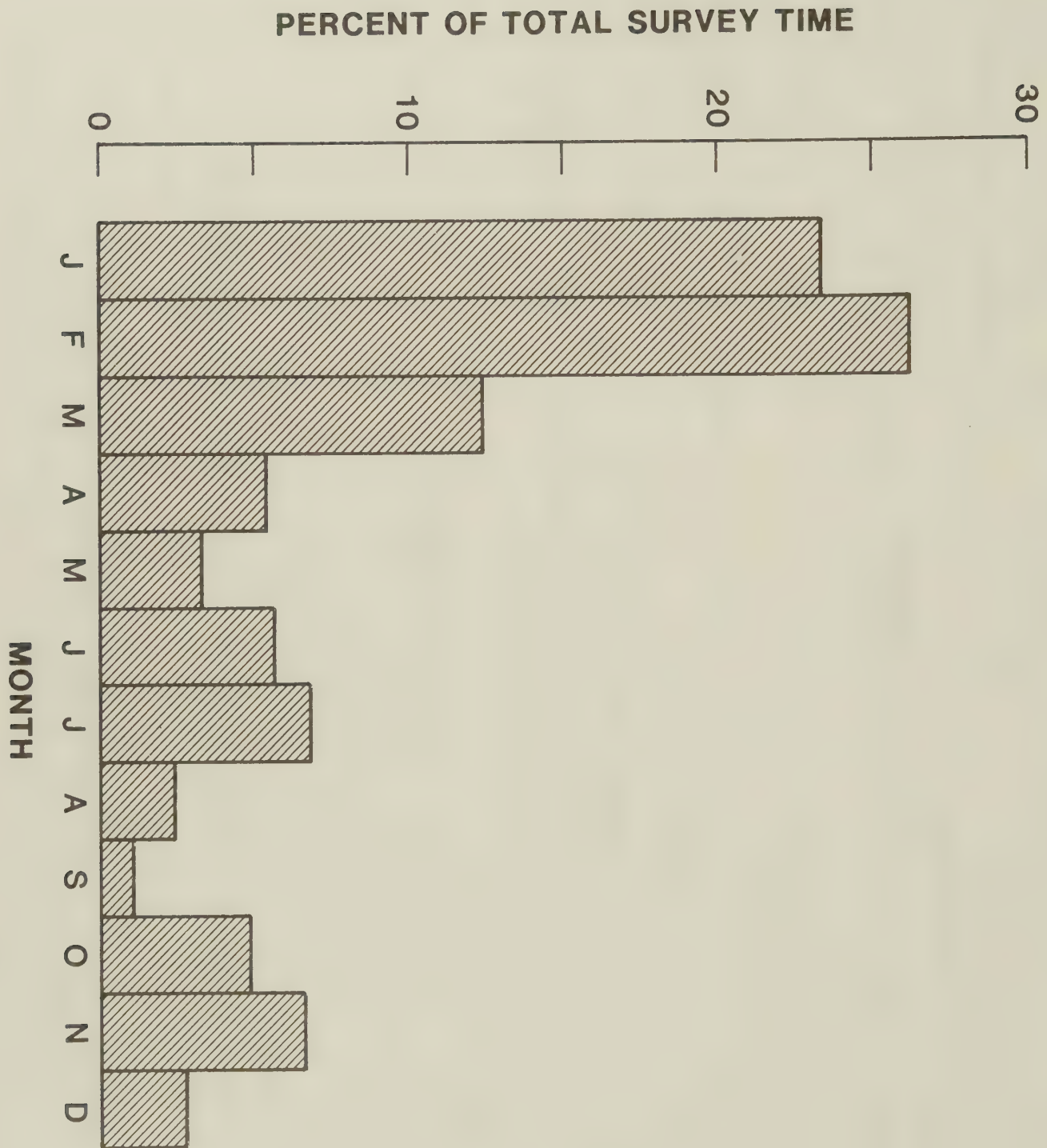


Figure 4. Distribution of survey effort by percent per month
(n=4333.5 survey hours).

PLOT 1 -7.51.07 THUR 23 AUG, 1984 JOB-7J08-852 SD 01SSPLA 9.2

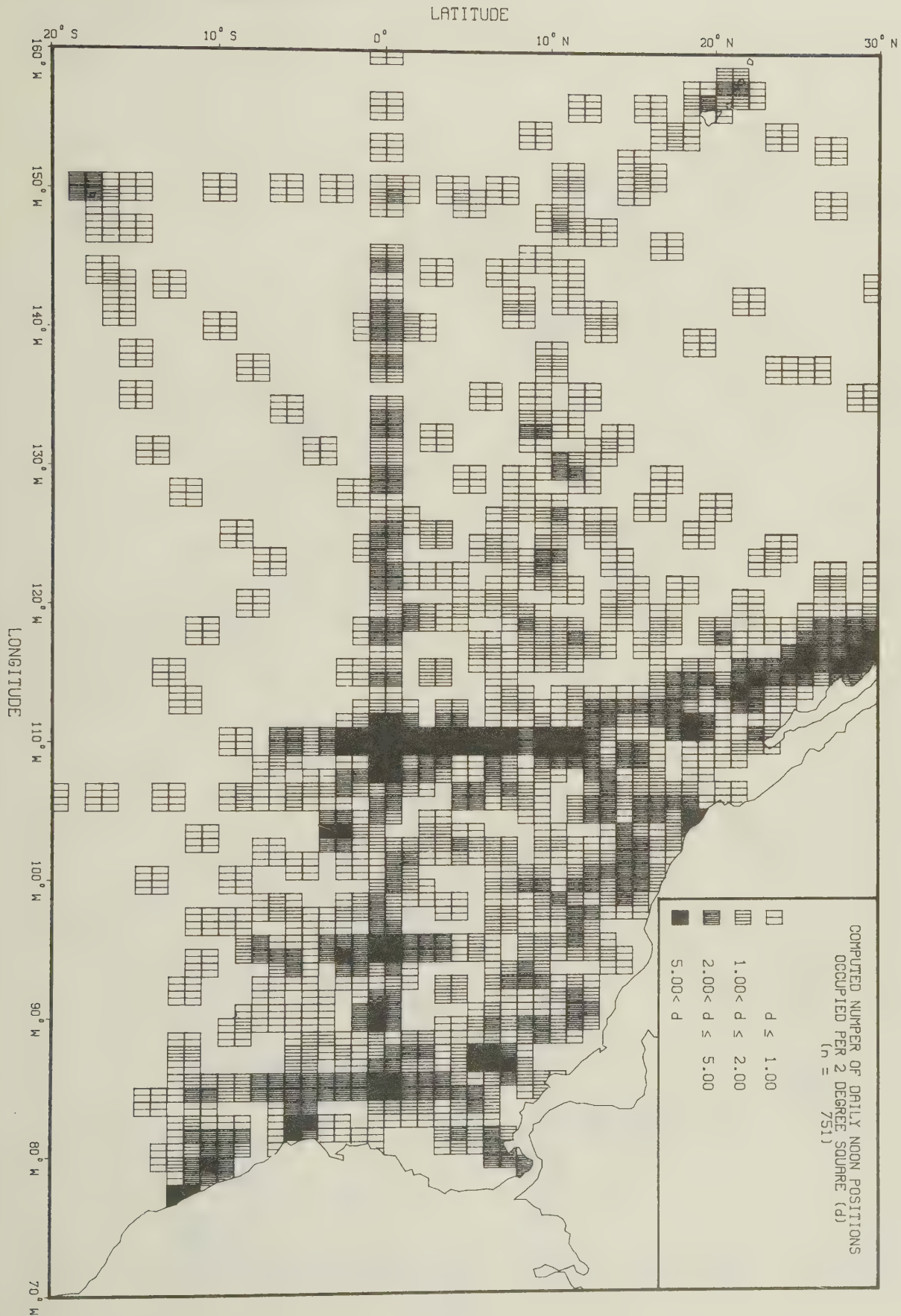


Figure 5. Distribution of marine bird survey coverage in the eastern tropical Pacific by the author.

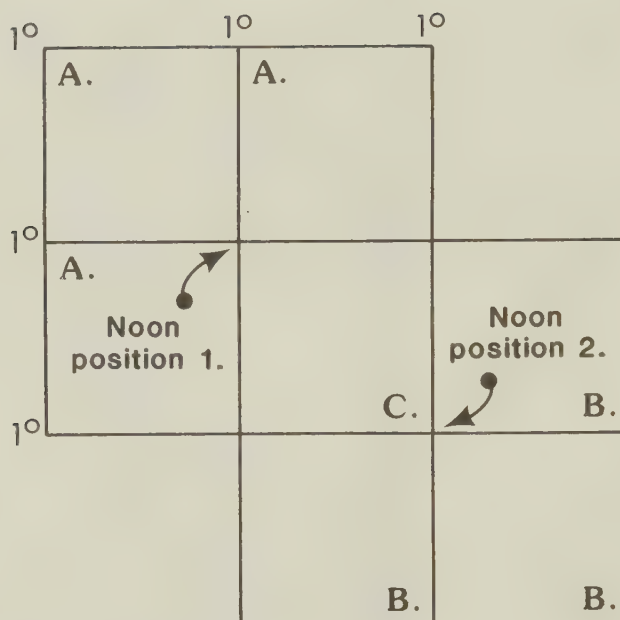
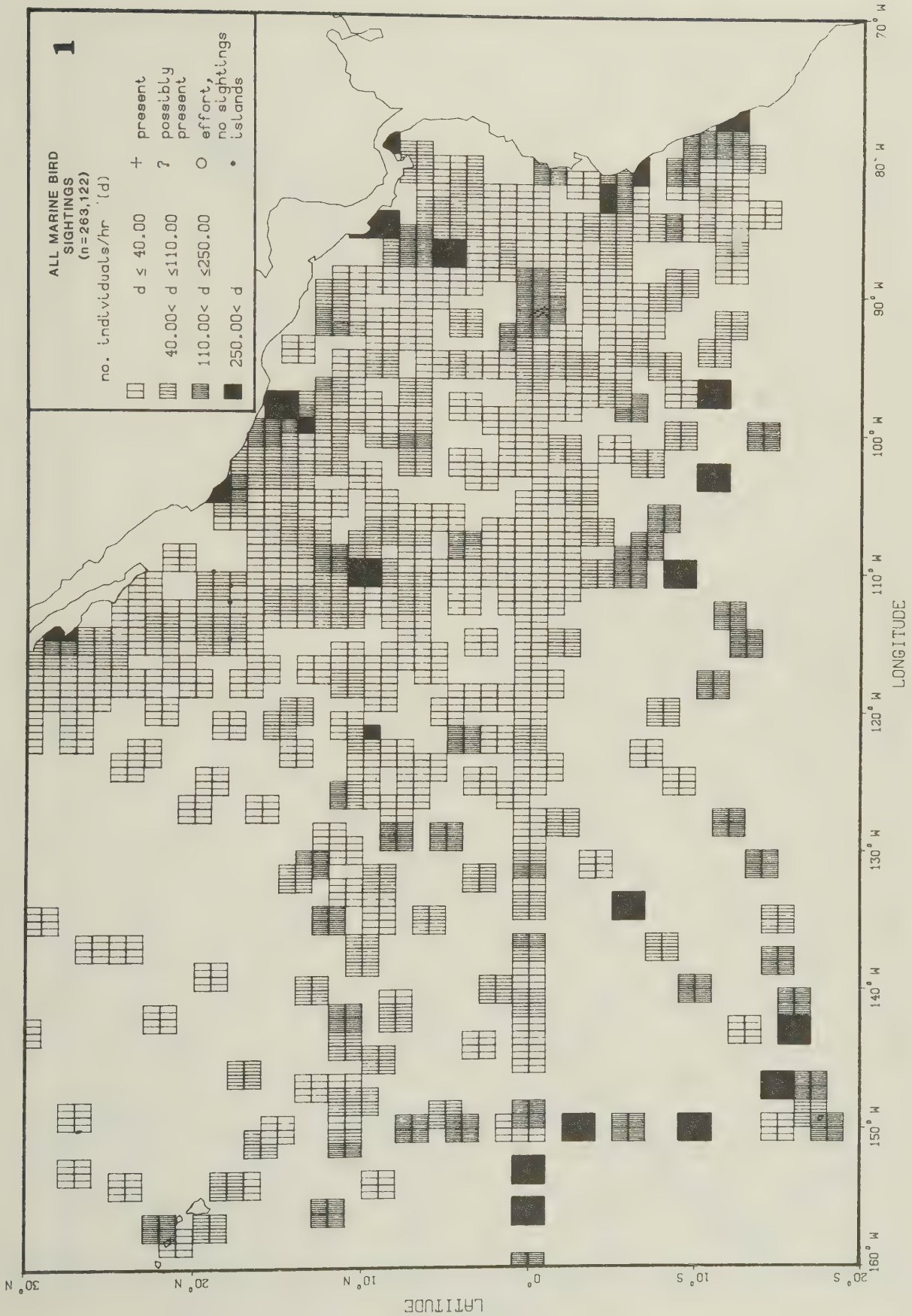
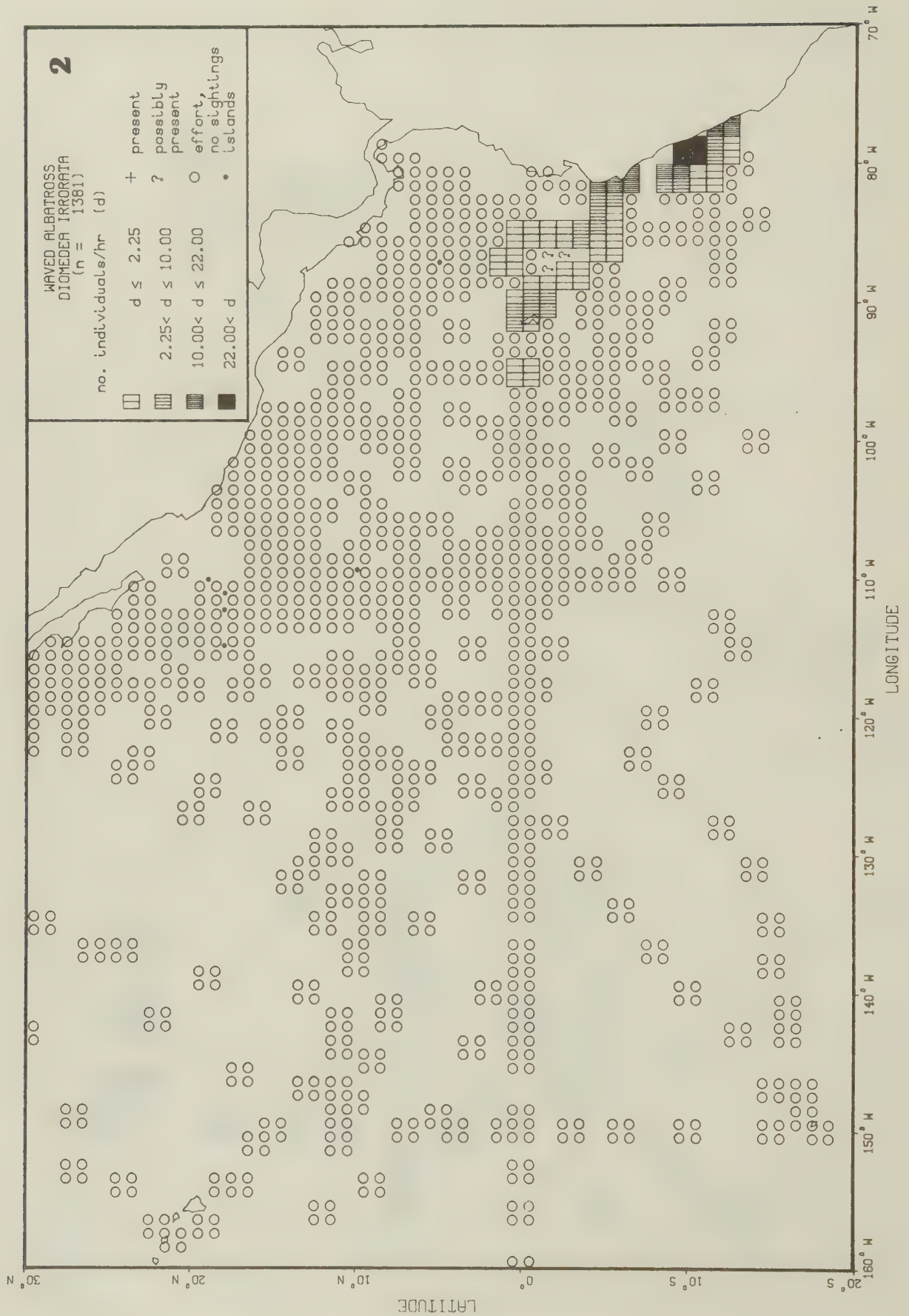
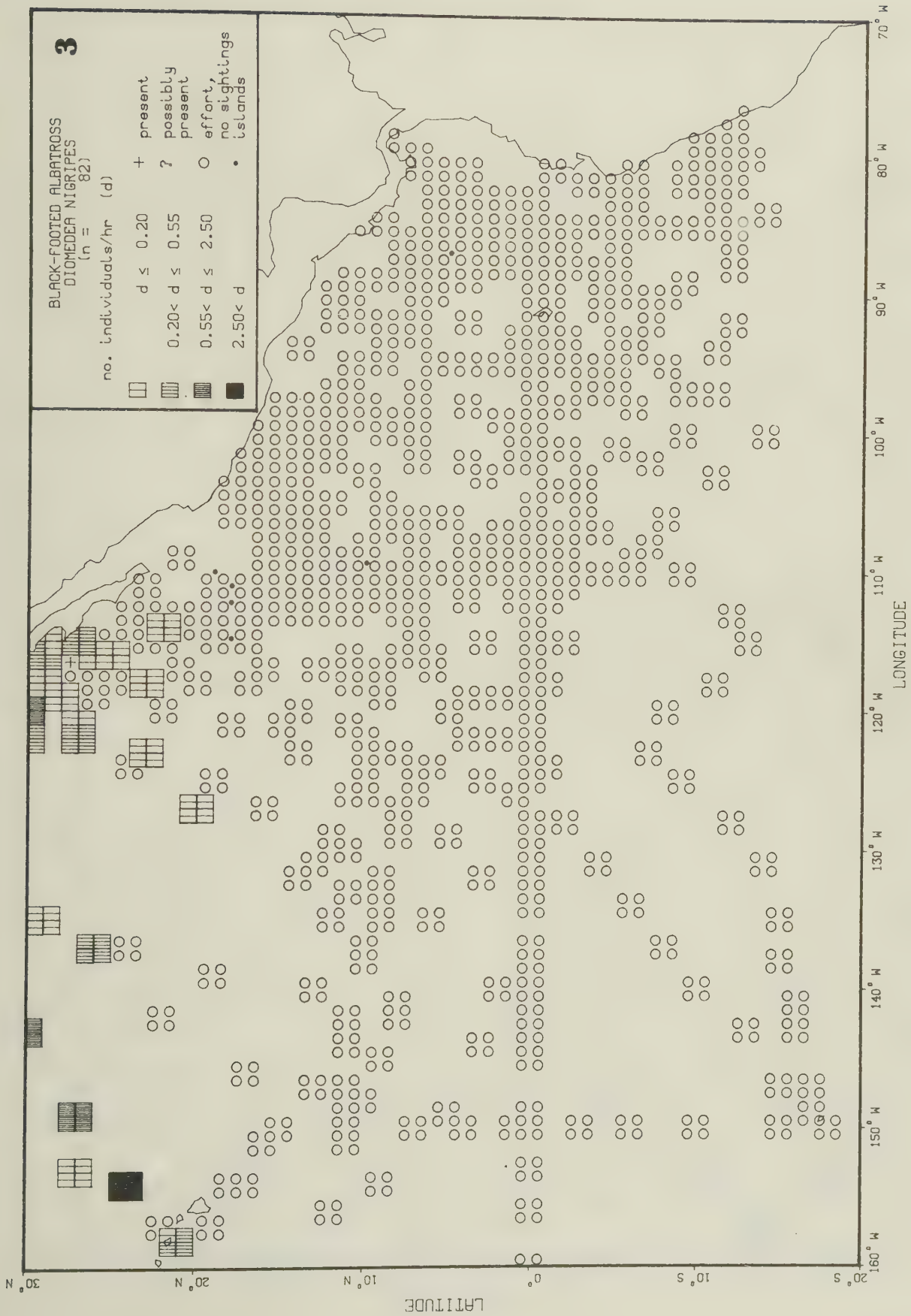
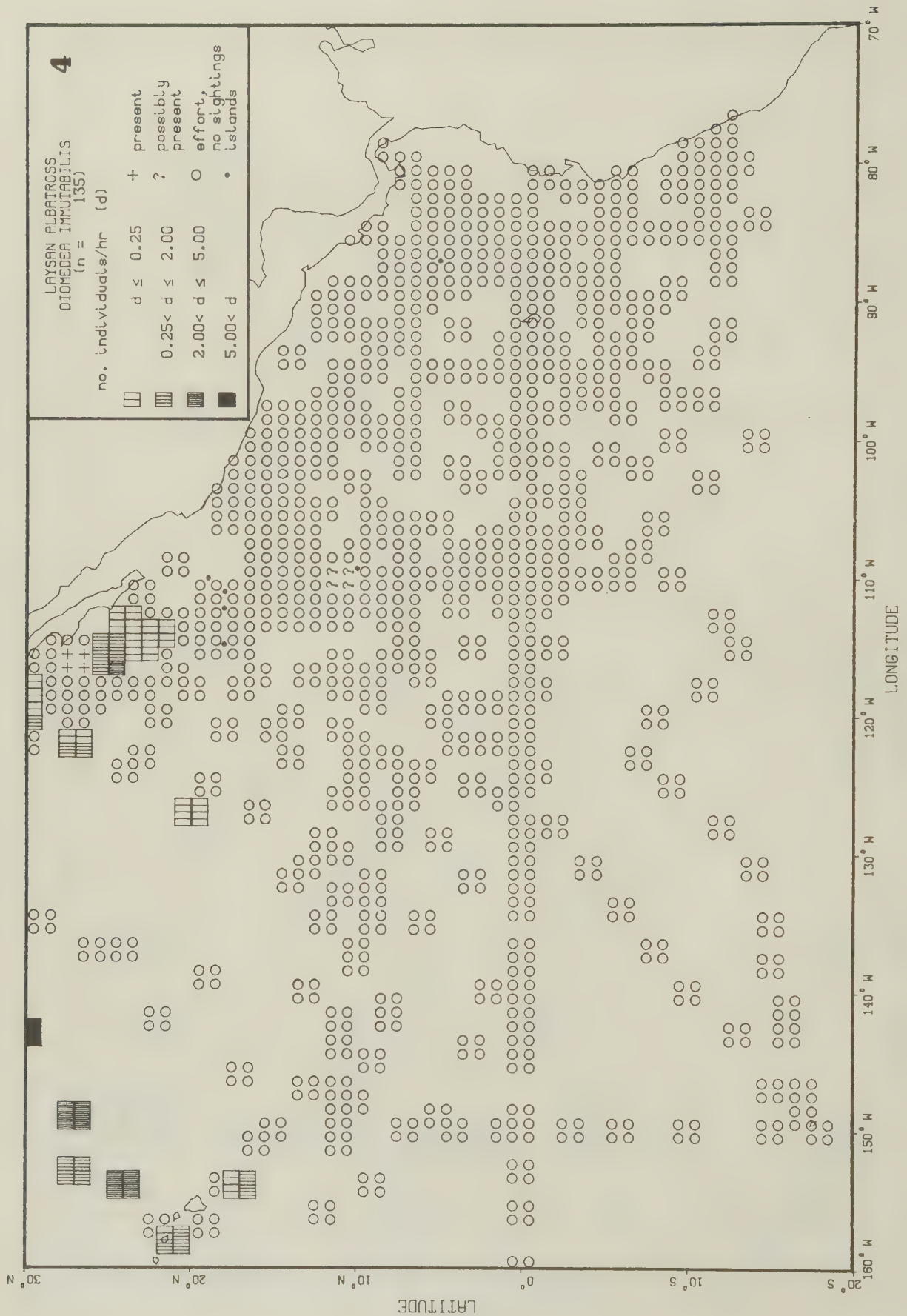


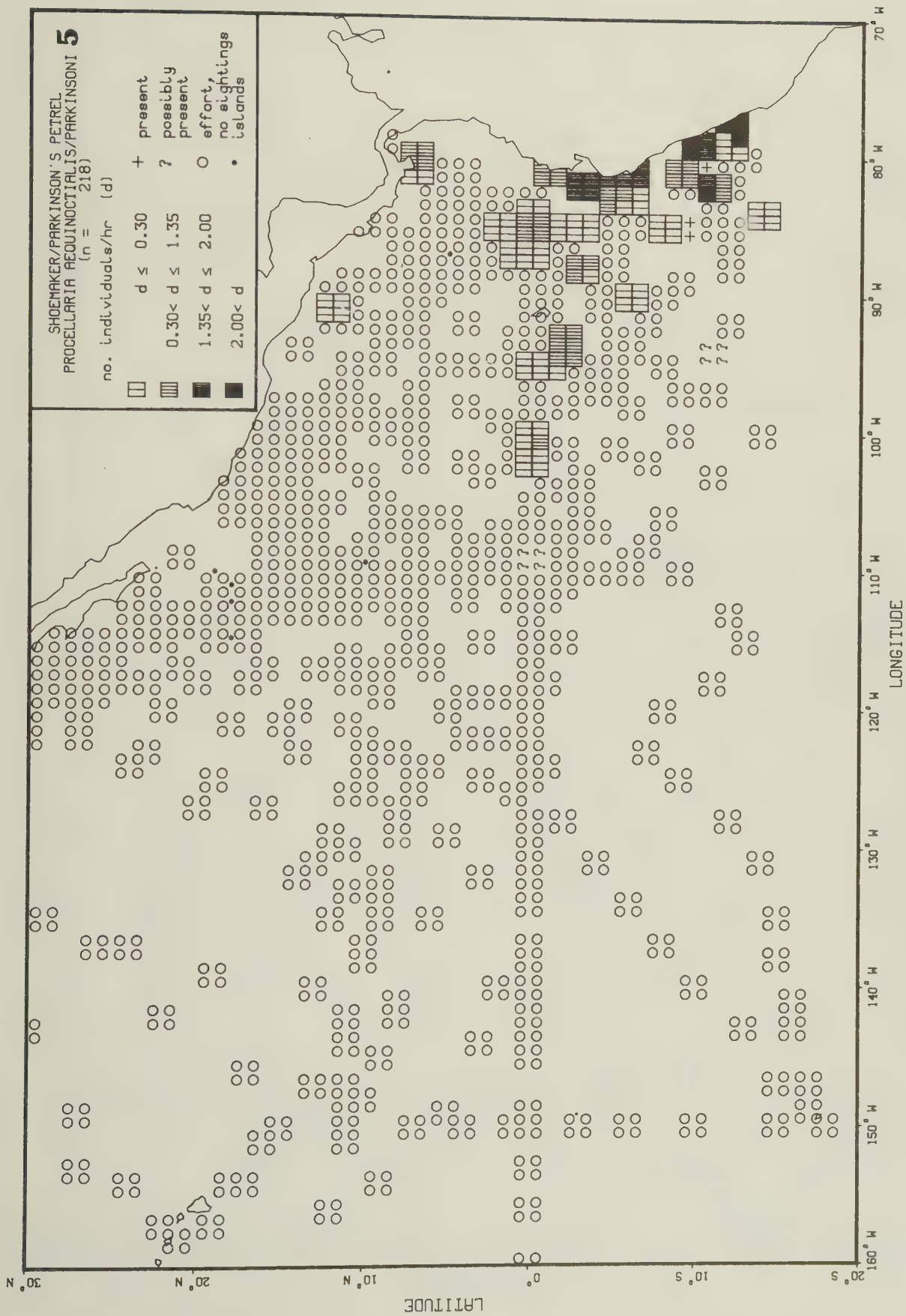
Figure 6. Plotting methods. Noon positions 1 and 2 are assigned to the nearest center of a 2° square. The results, by species, from a days observations with noon position 1 are plotted in the "A" squares; in "B" squares for noon position 2. In the overlapped "C" square, results are pooled (total birds/total hours). The same methods are used for different overlap patterns.

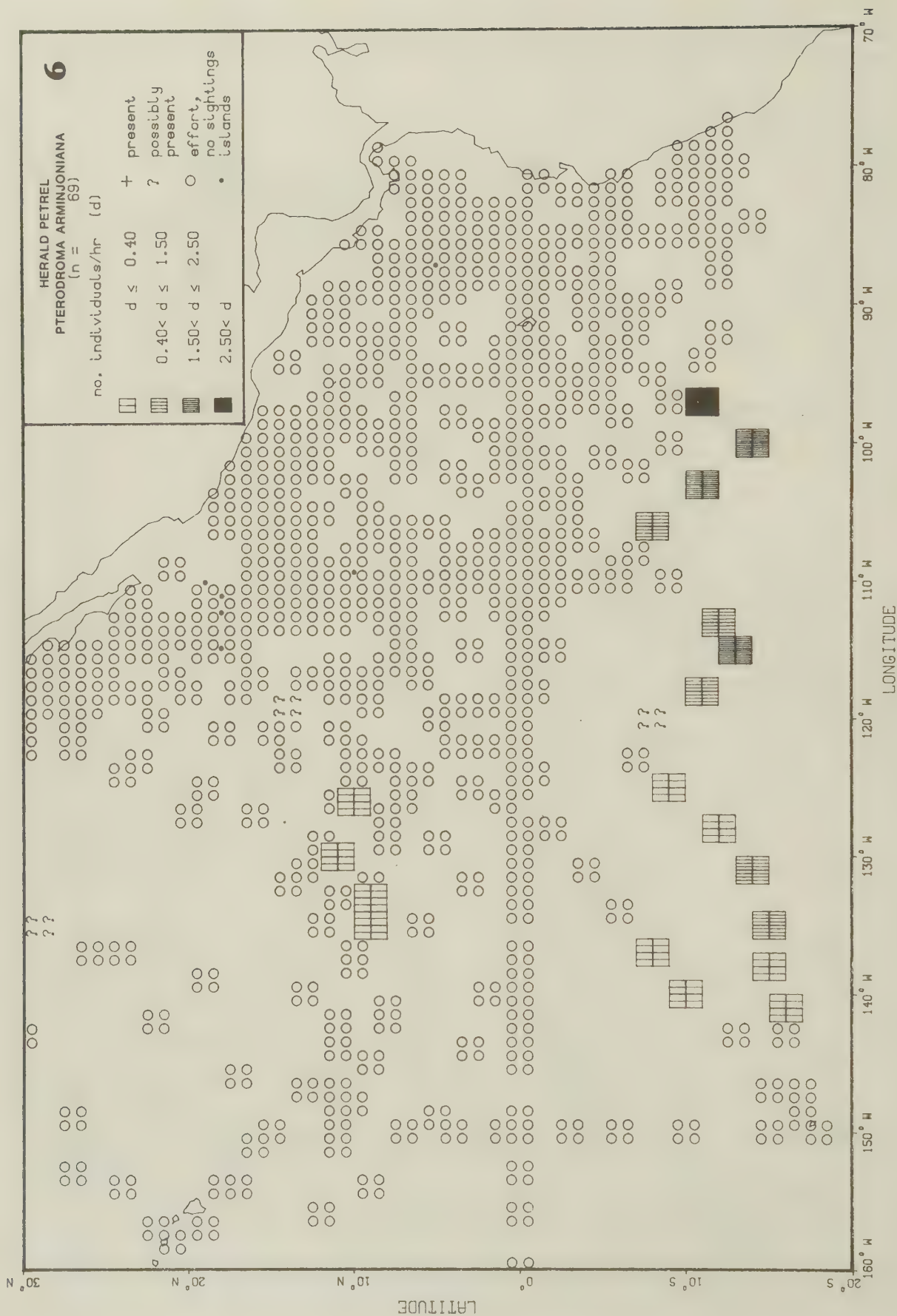


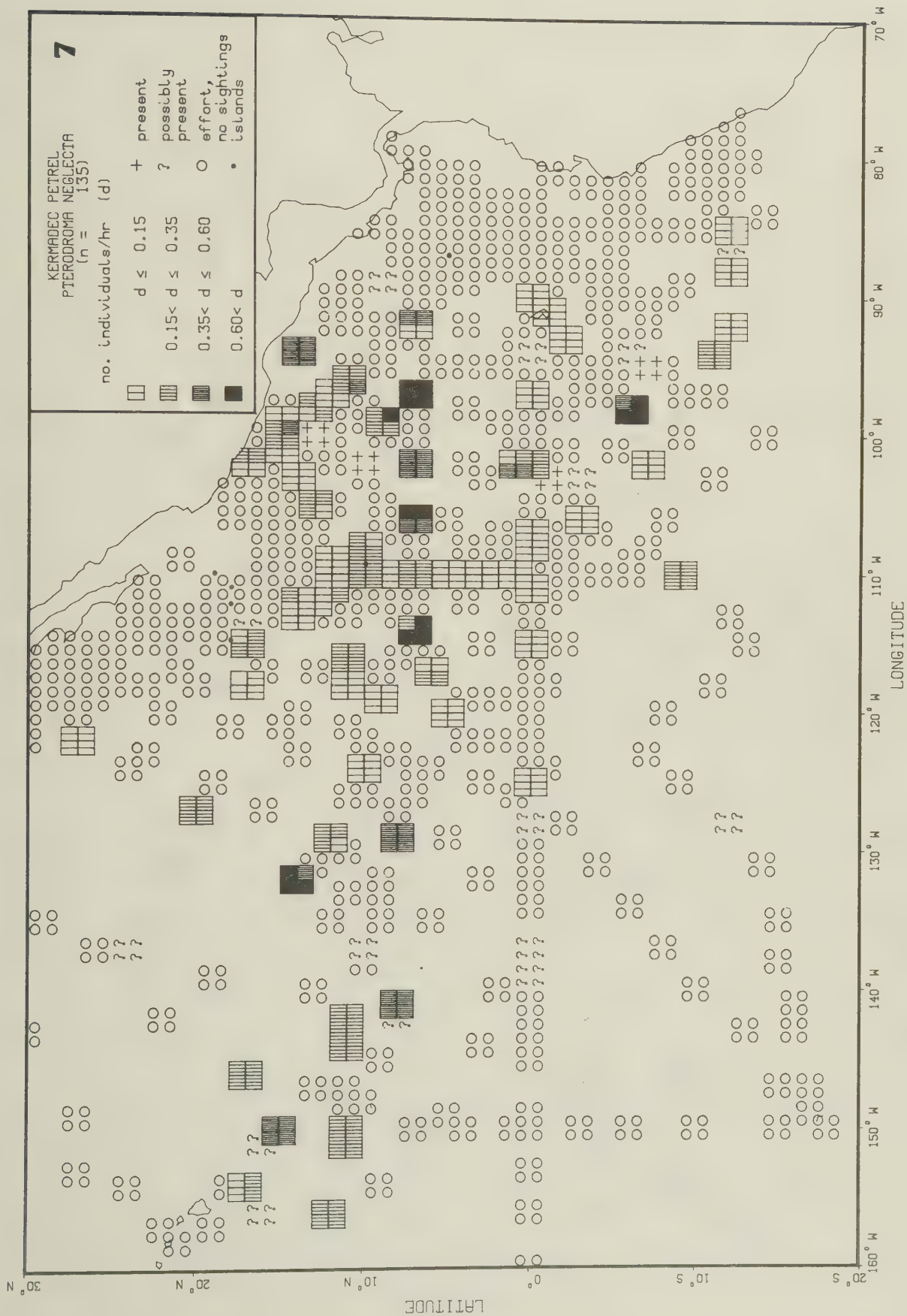


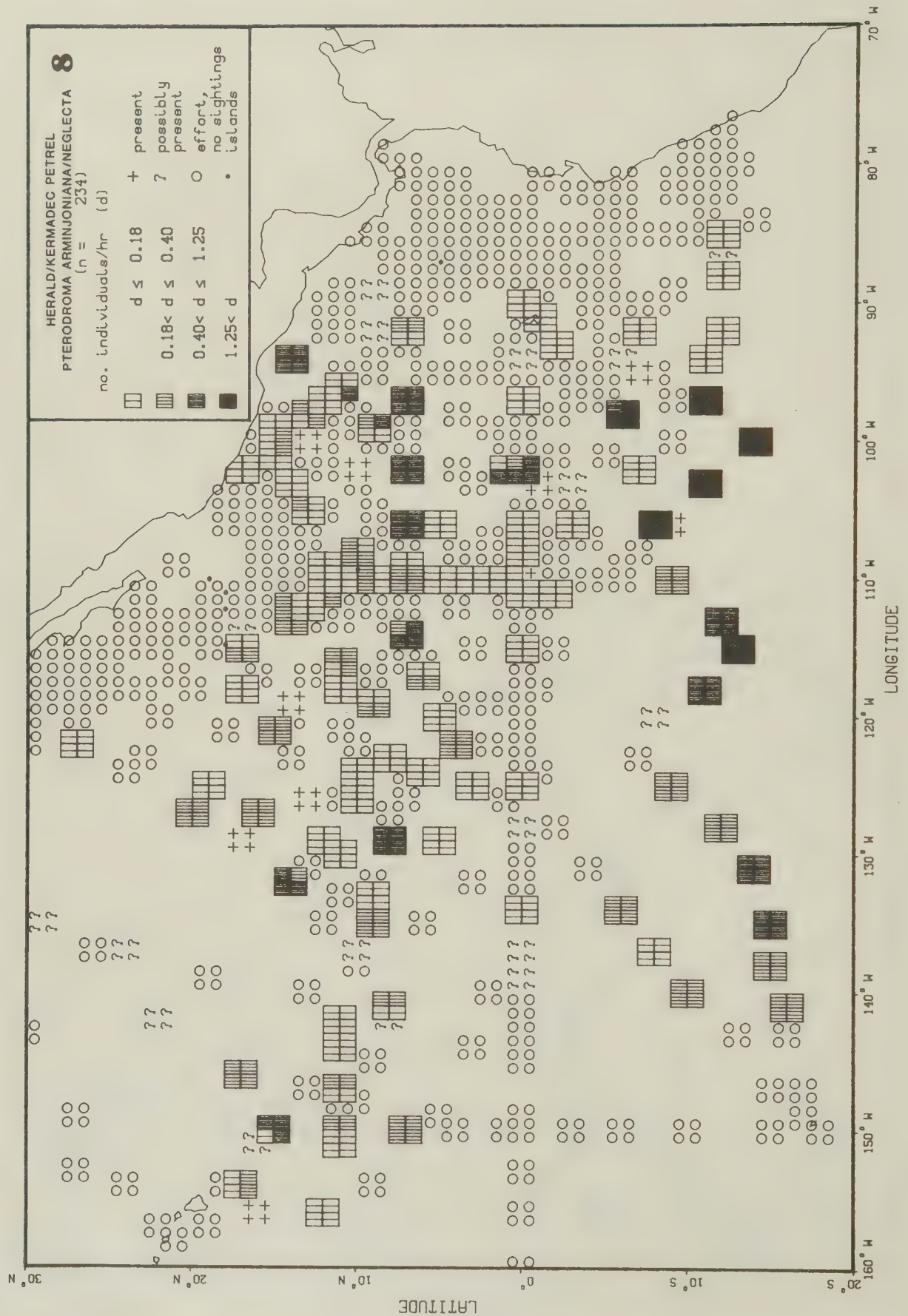


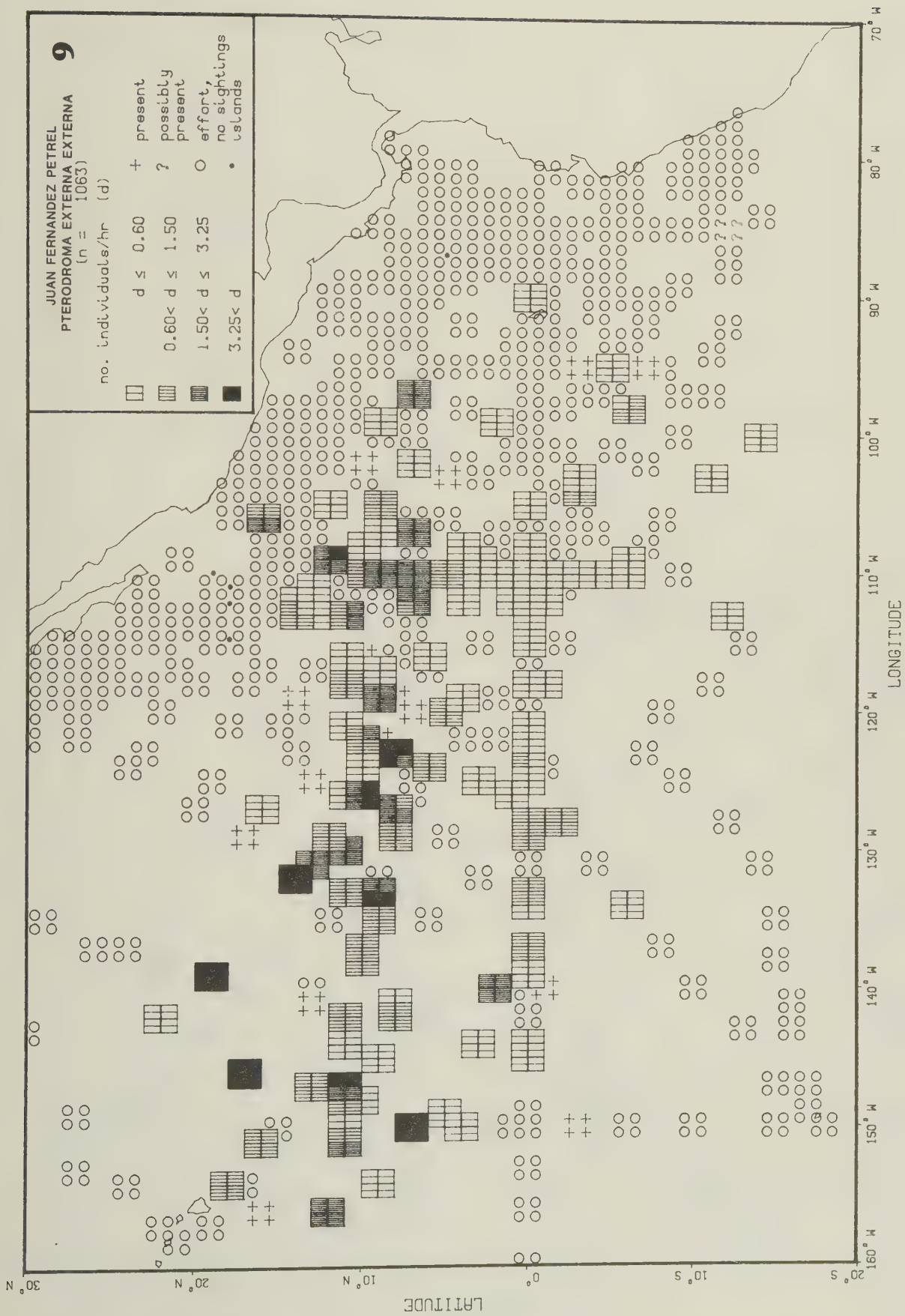


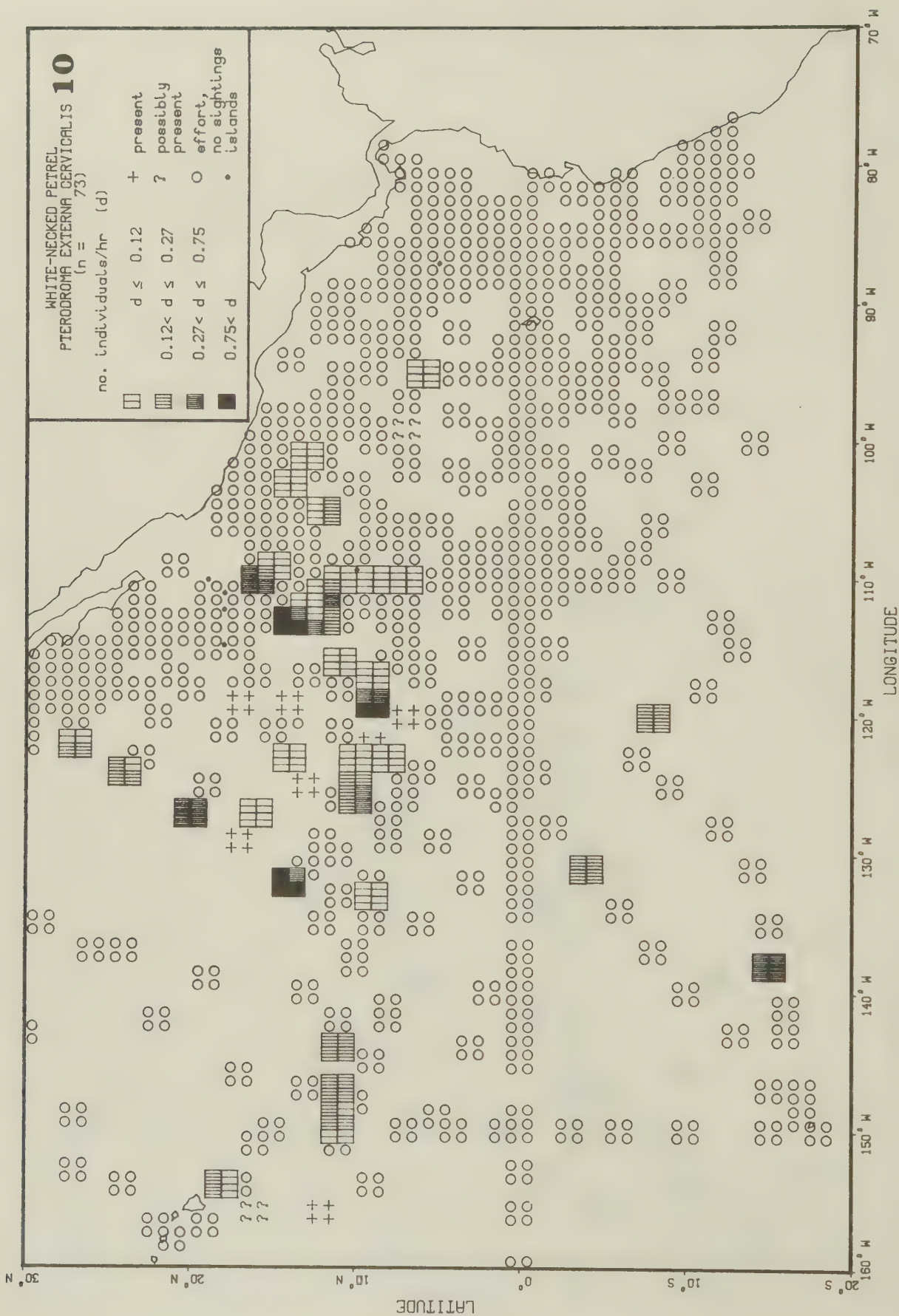


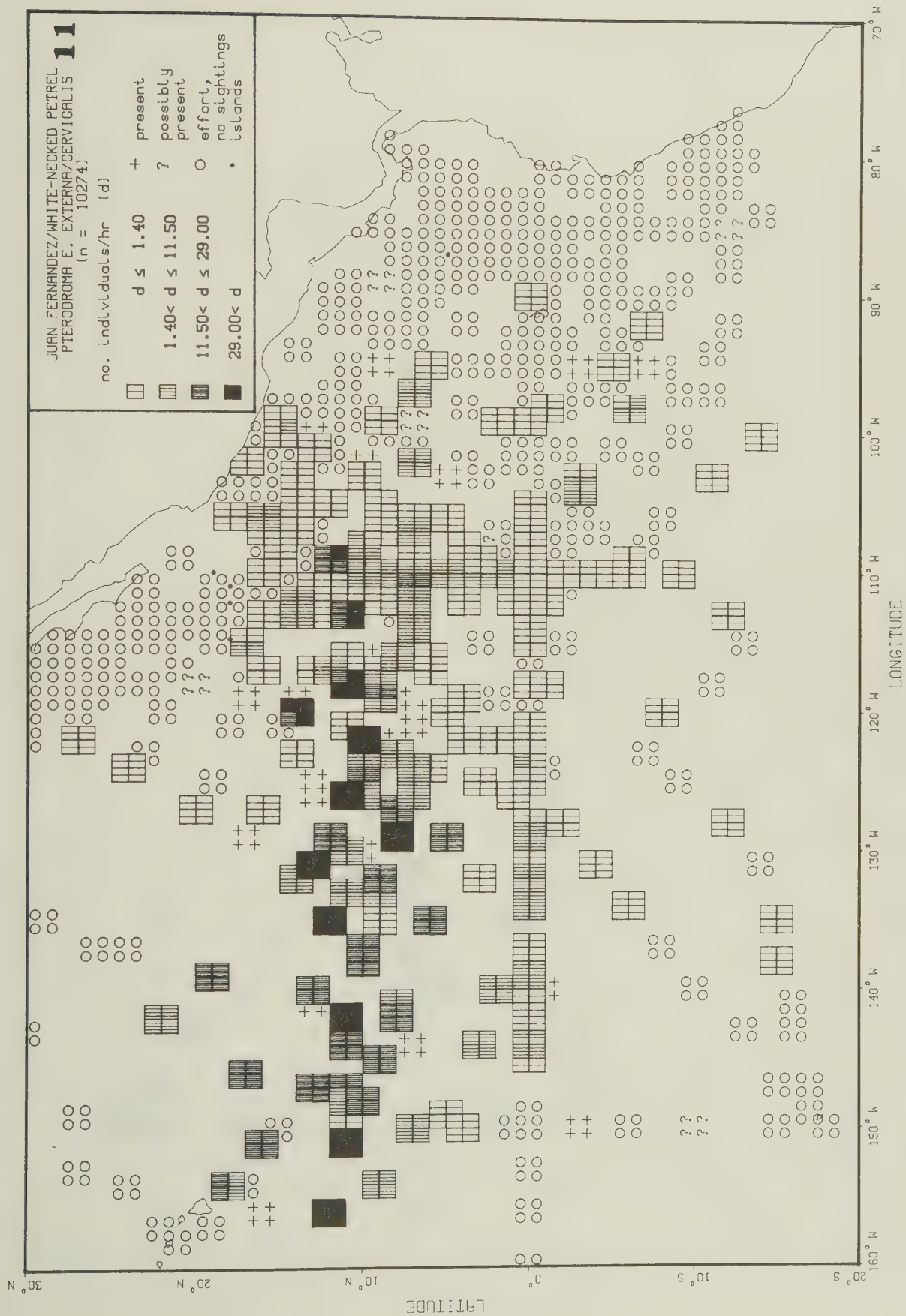


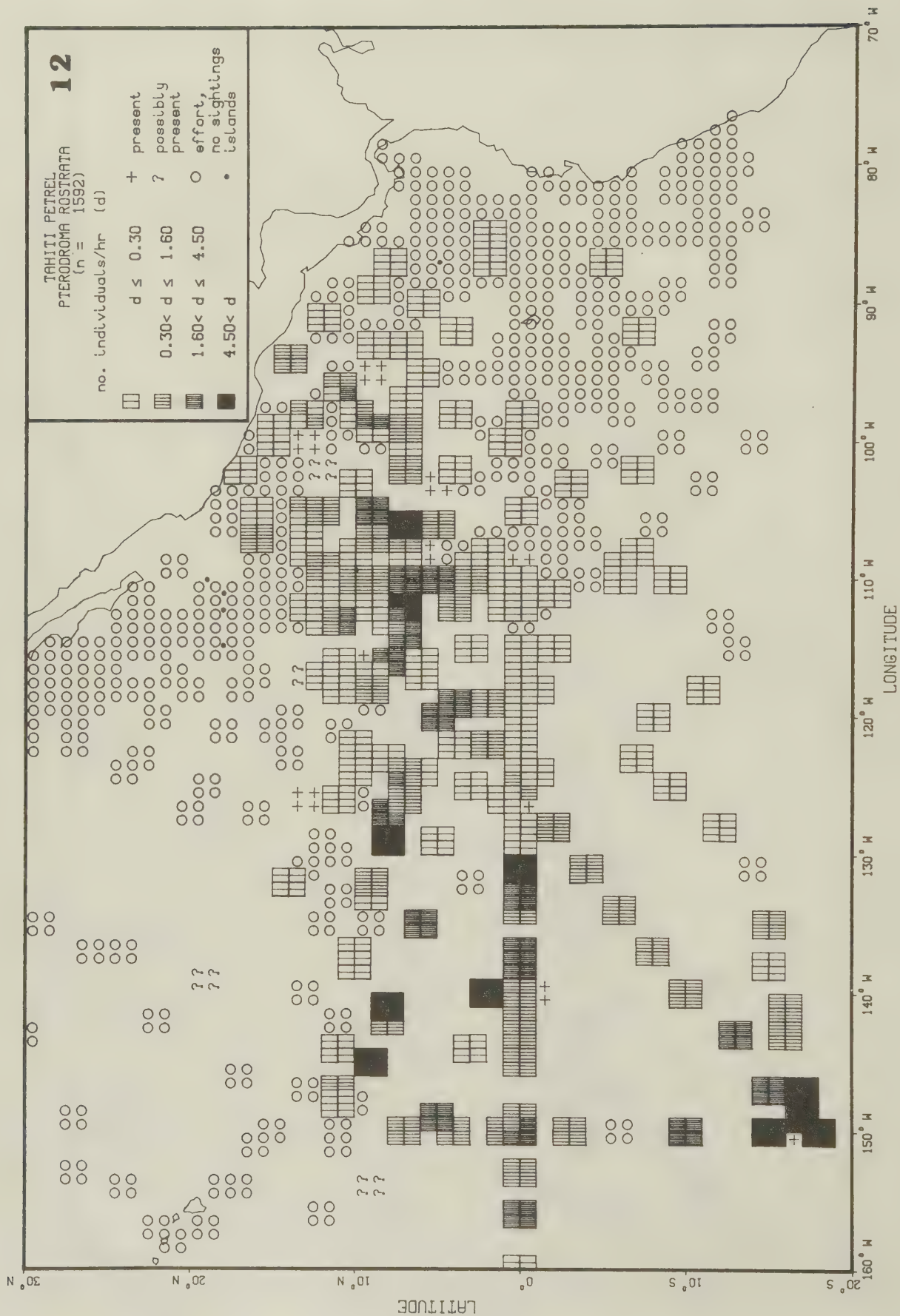


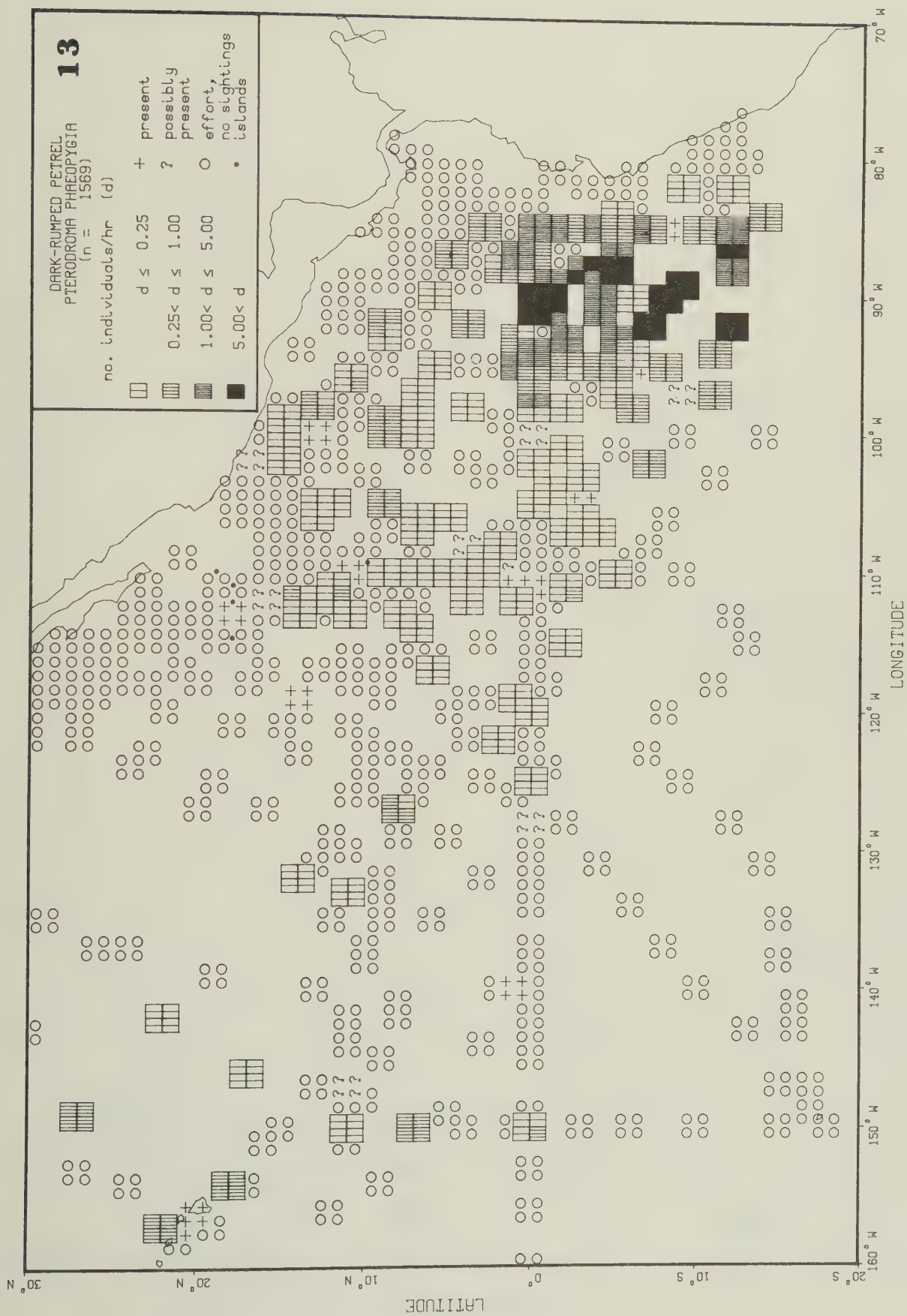


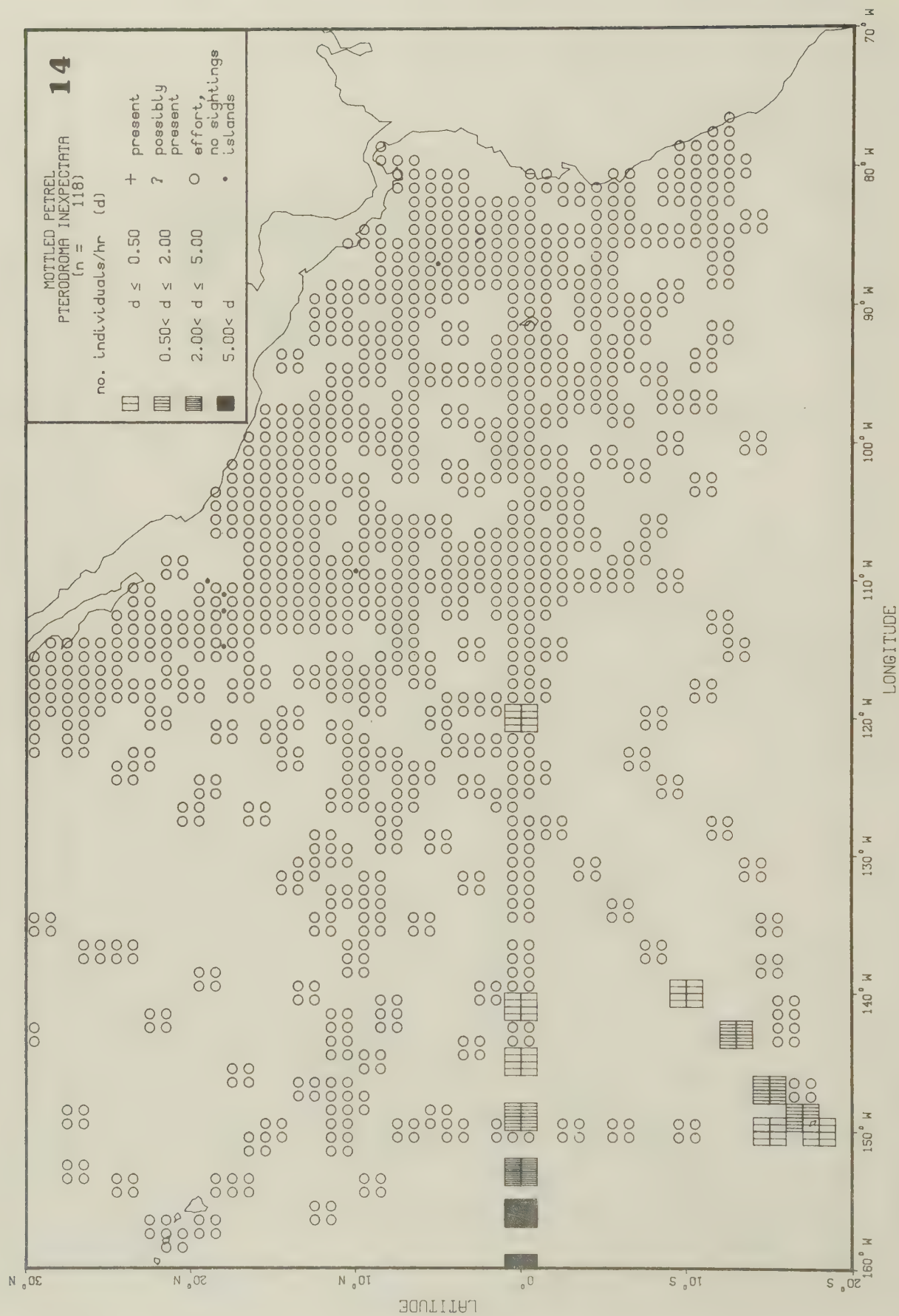


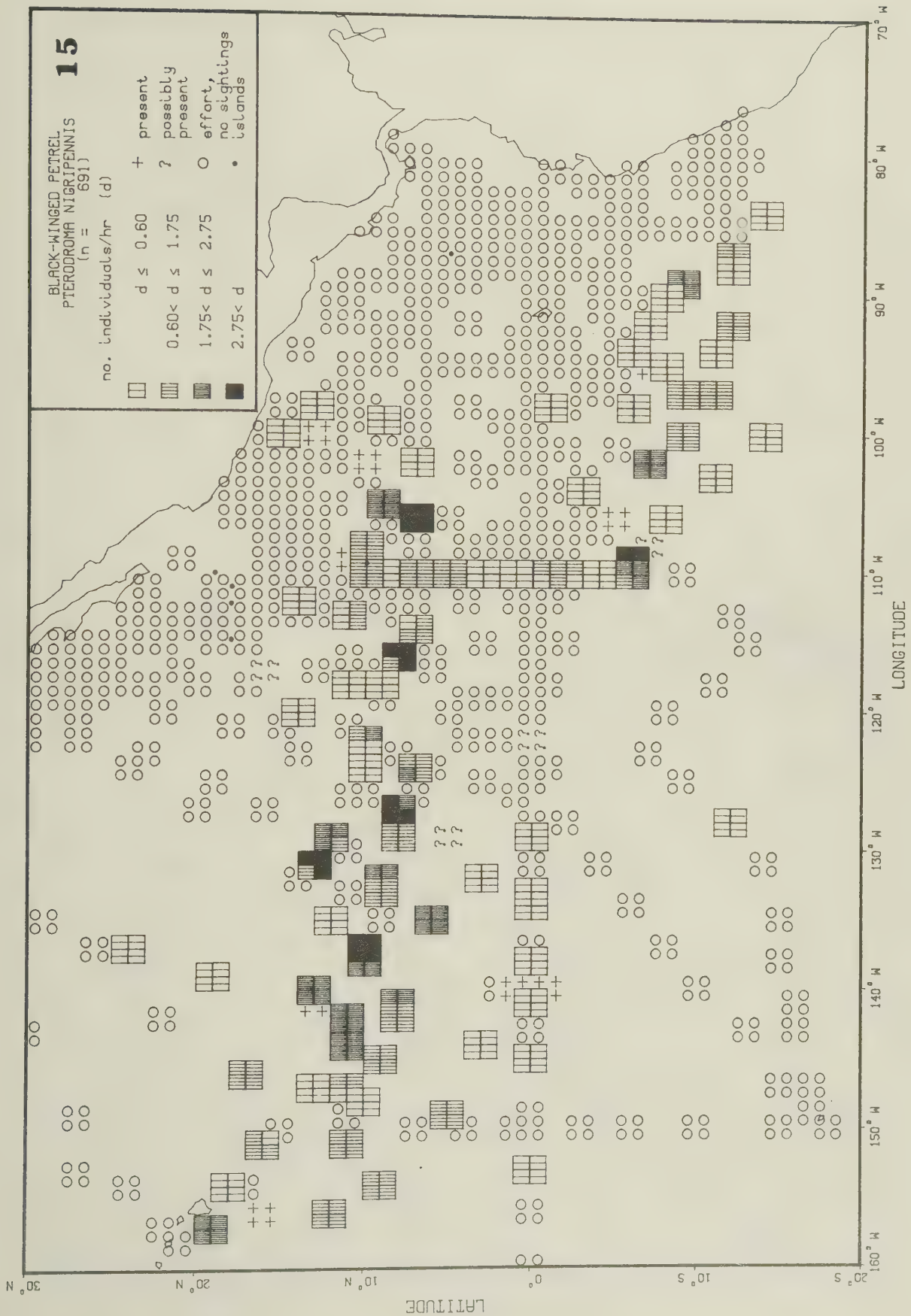


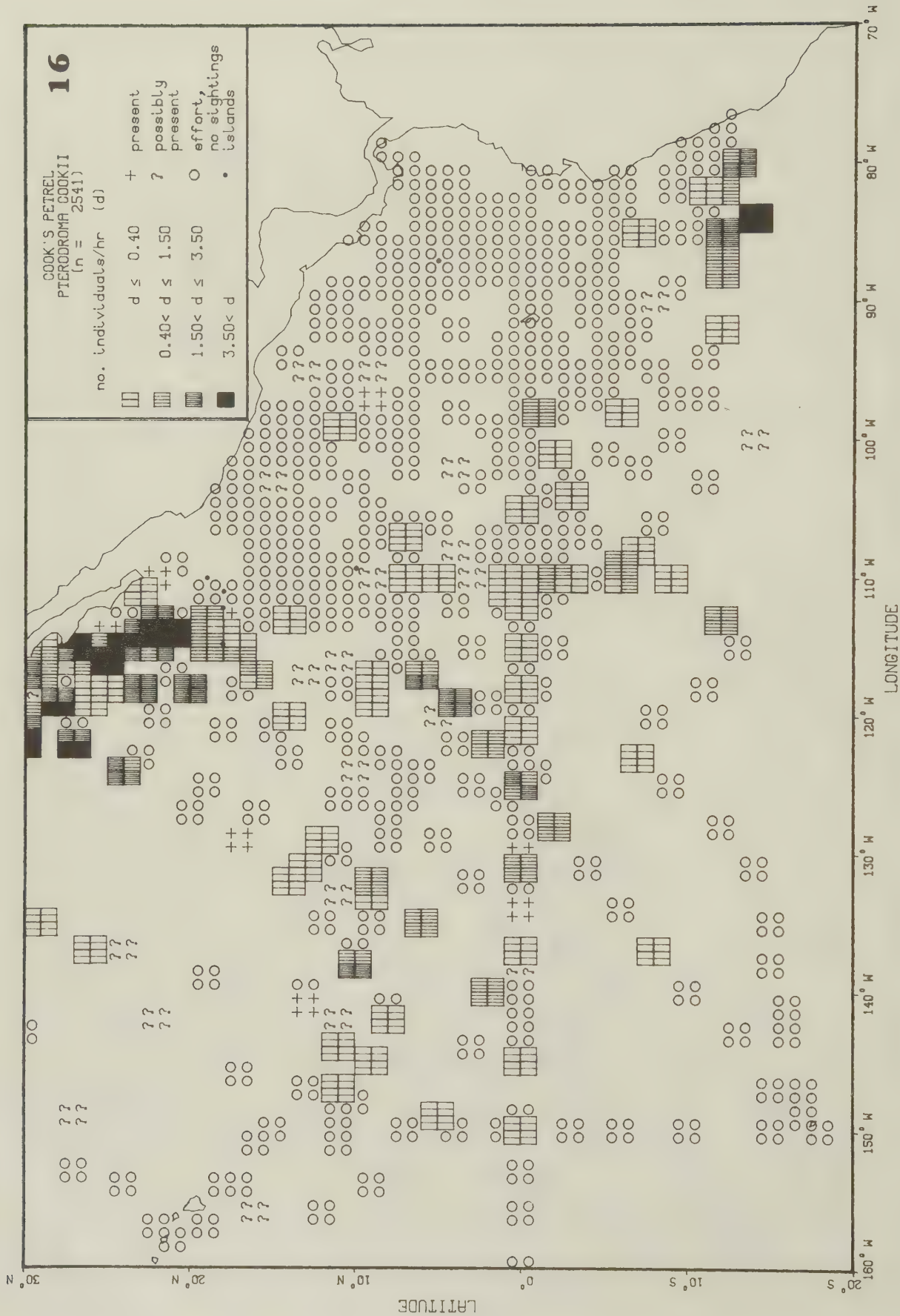


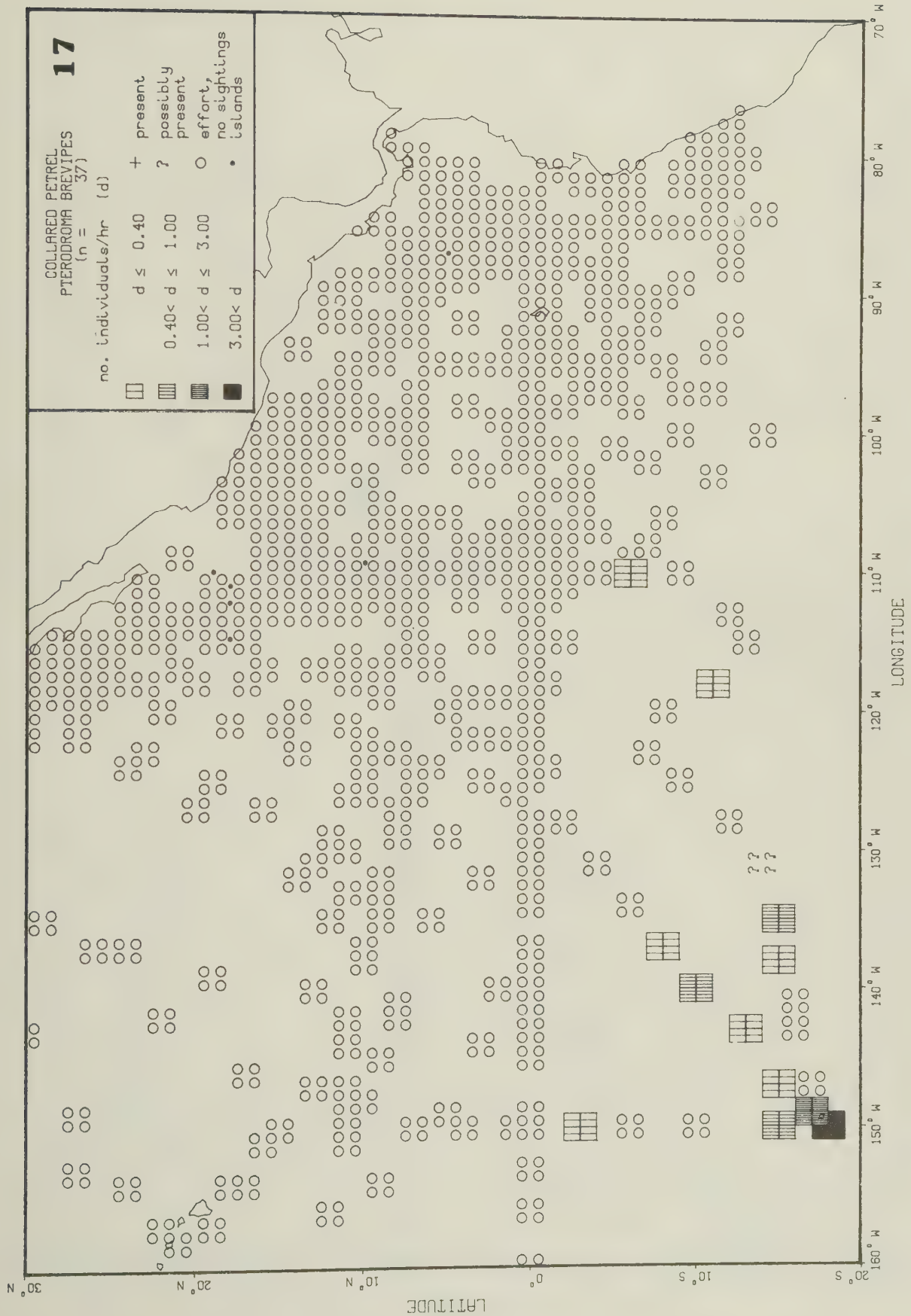


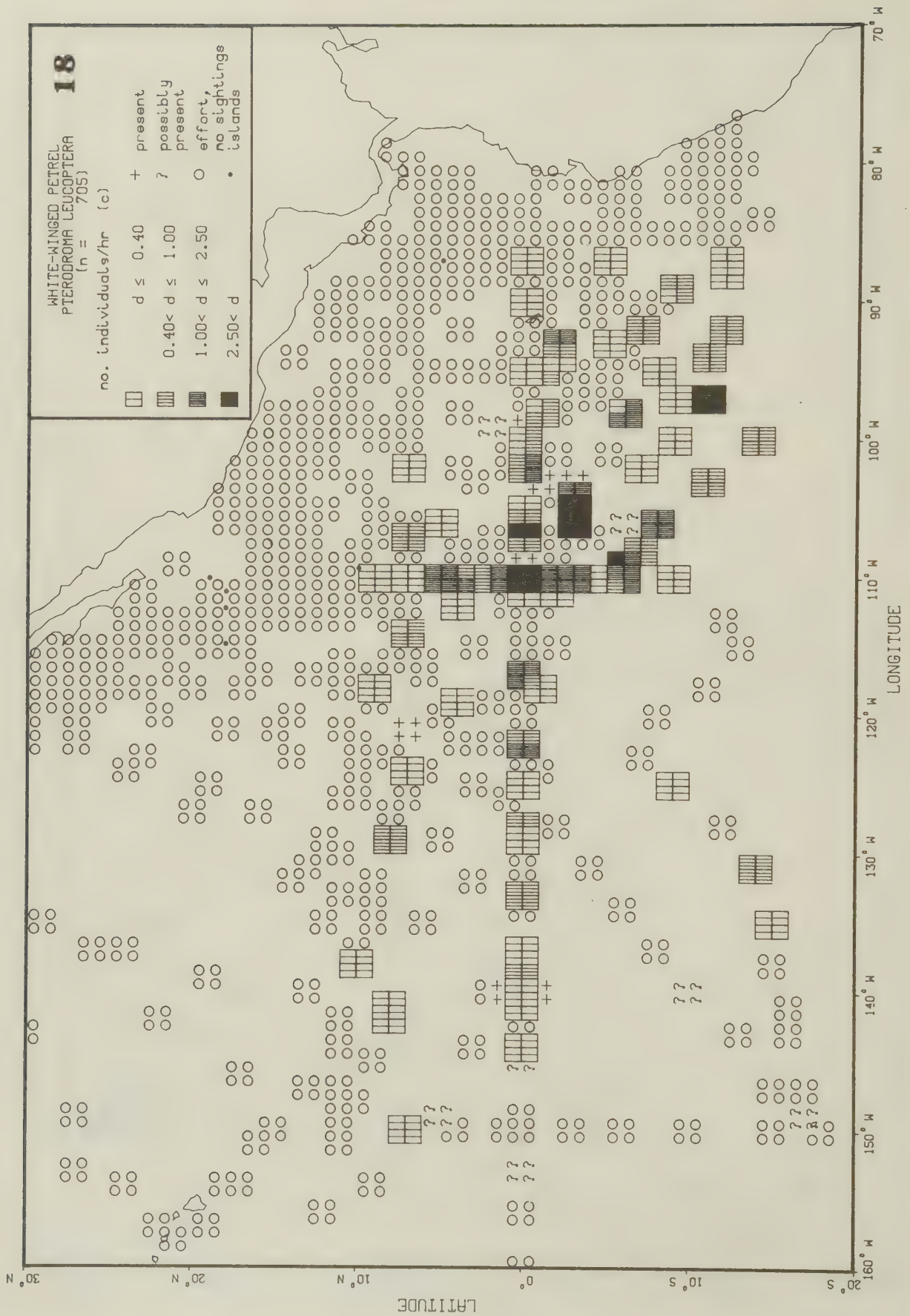


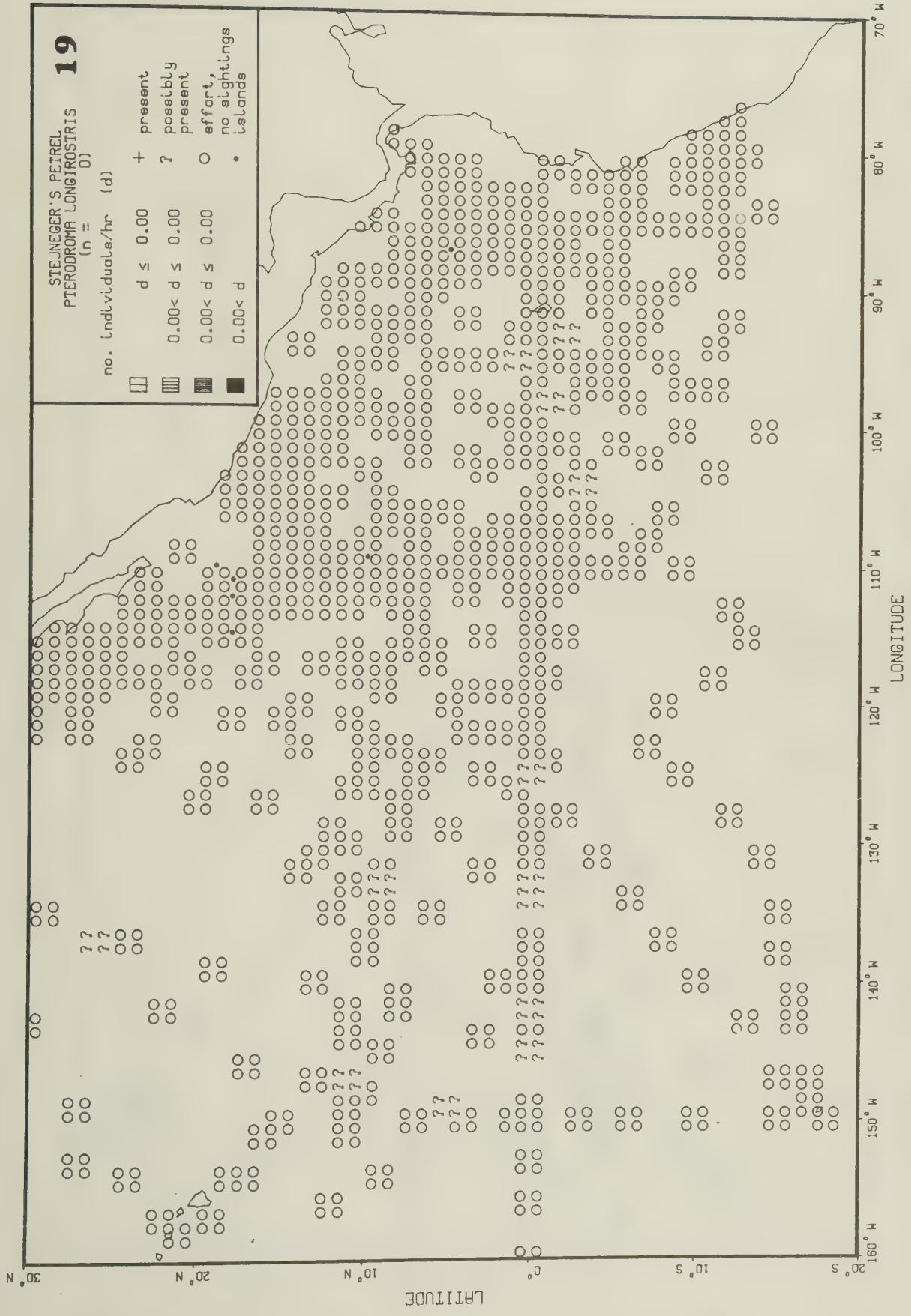


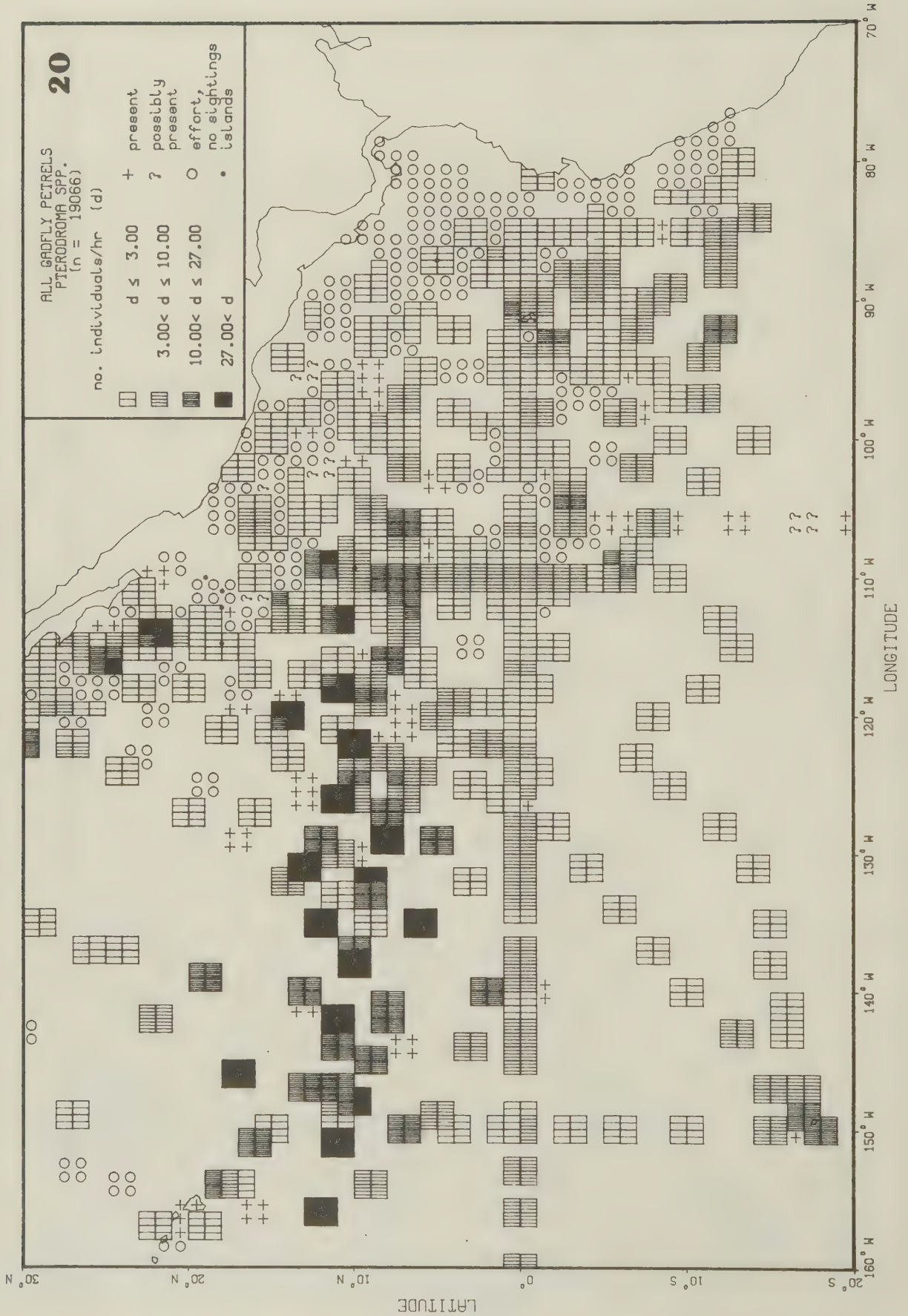


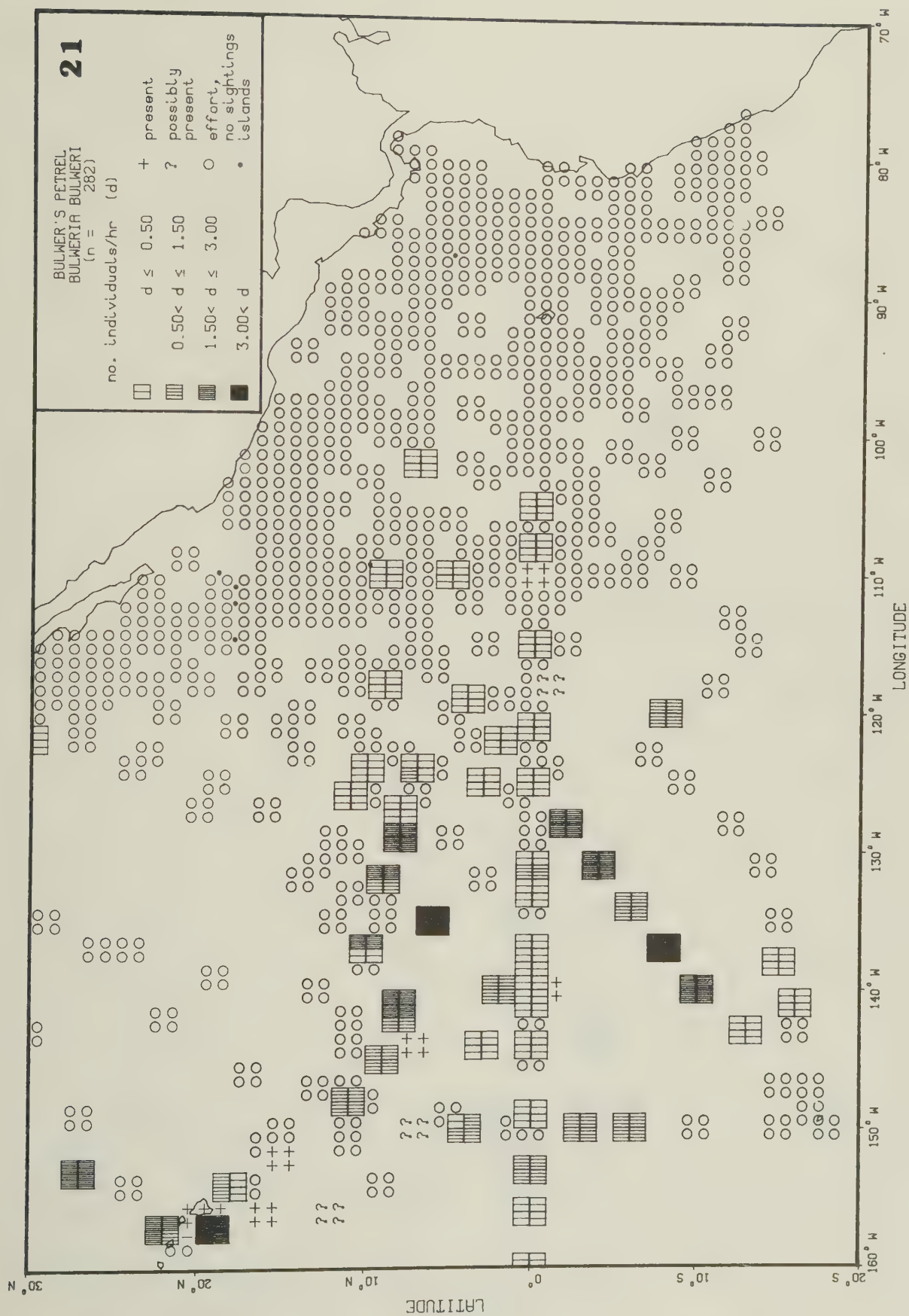


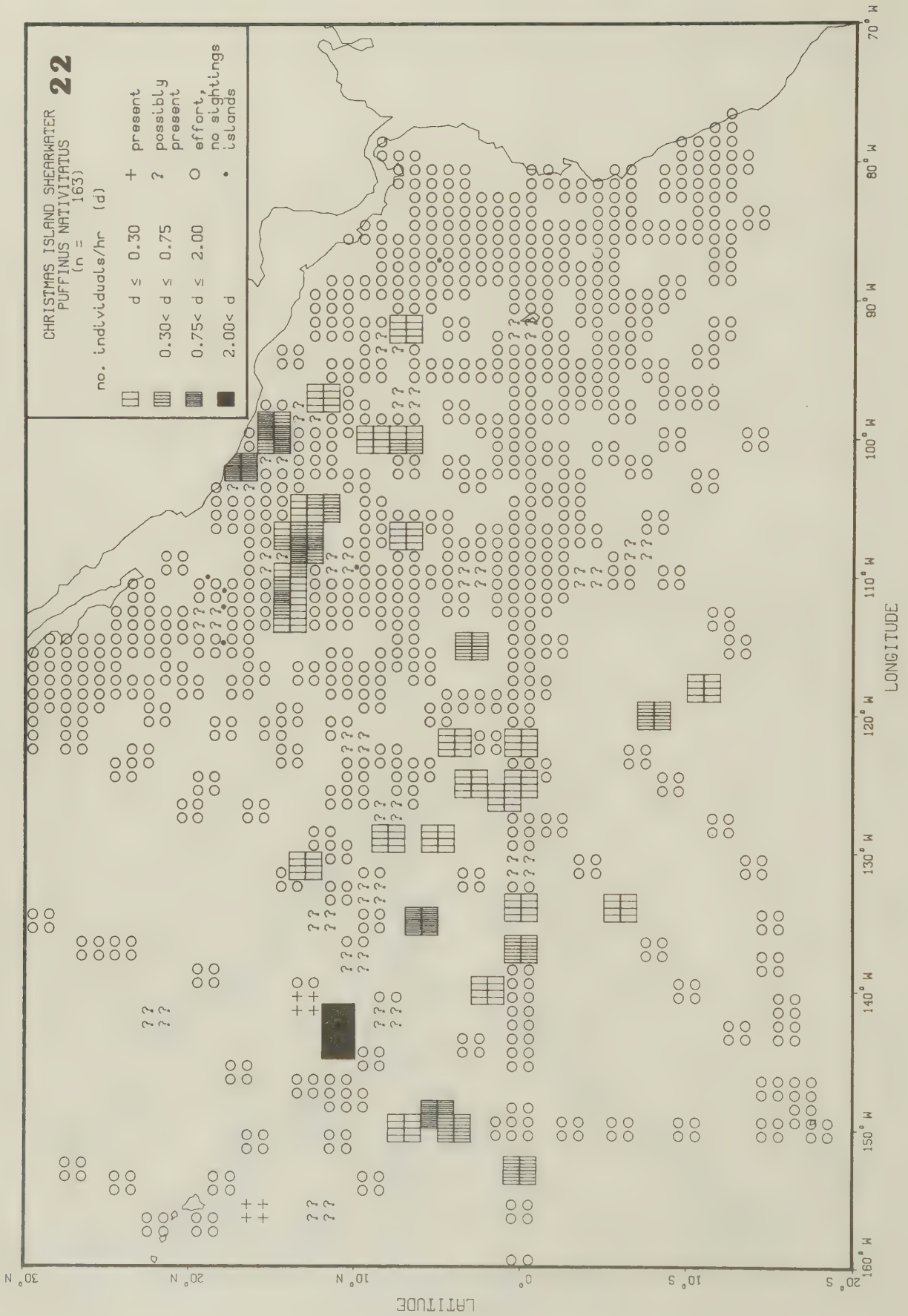


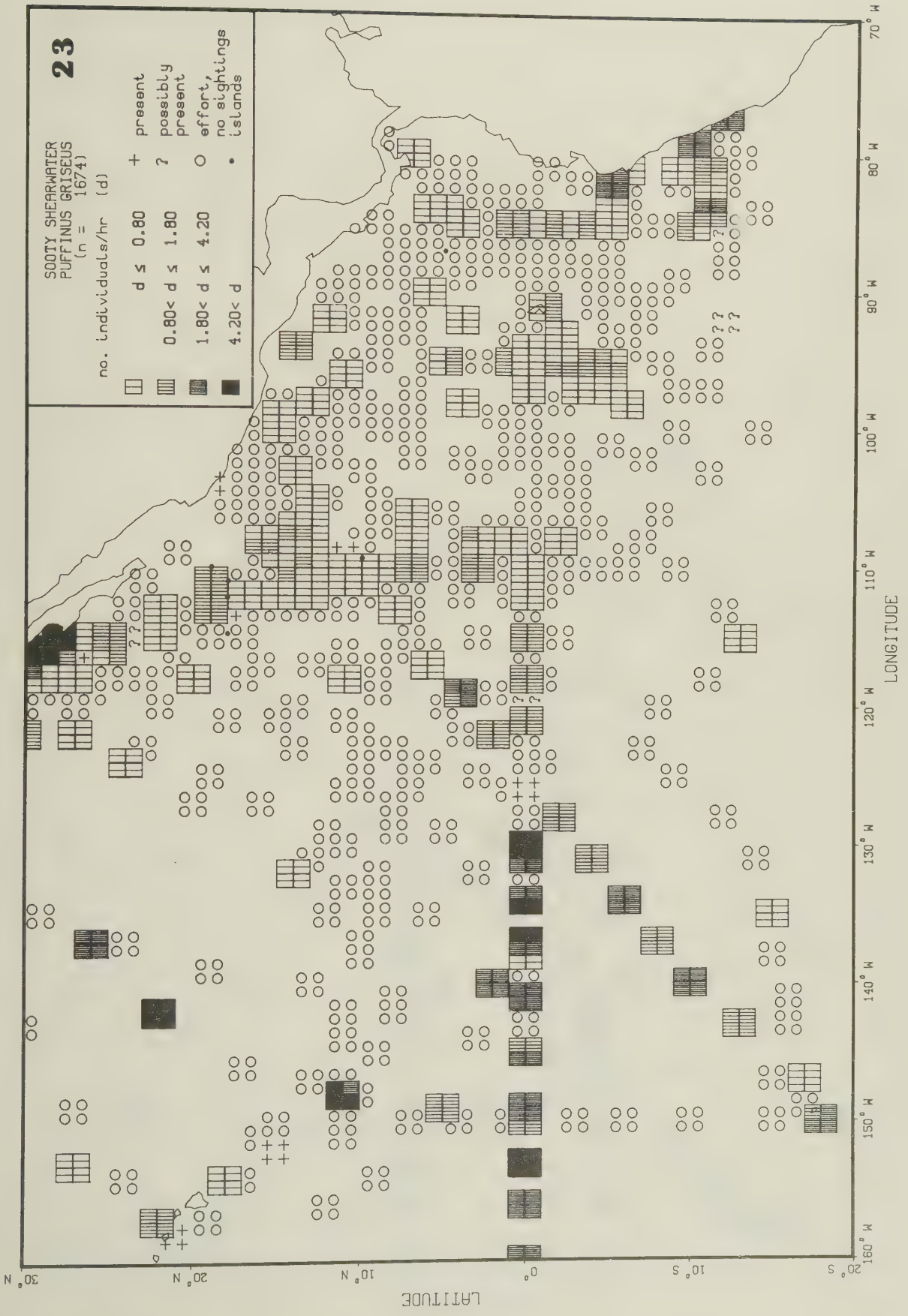


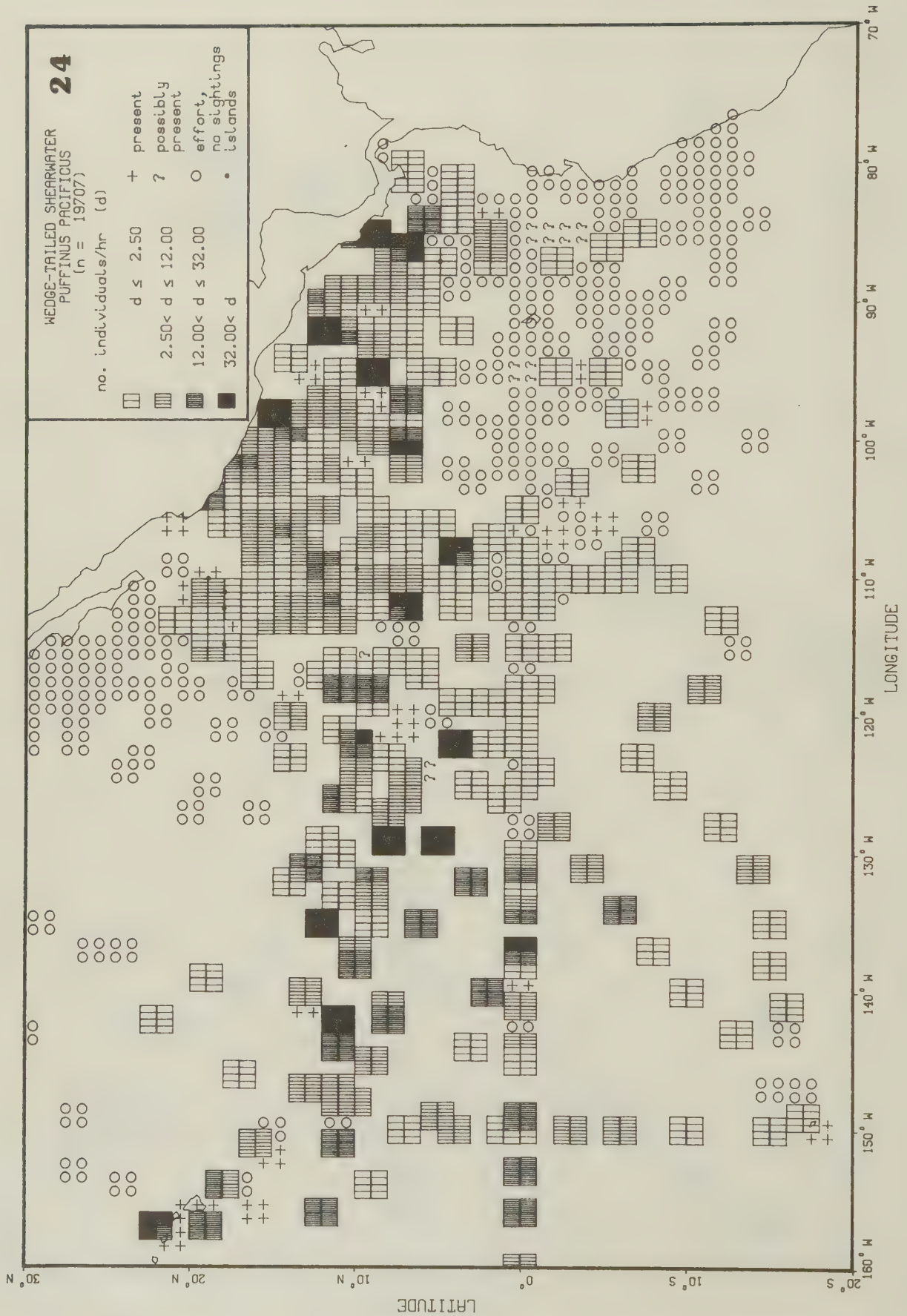


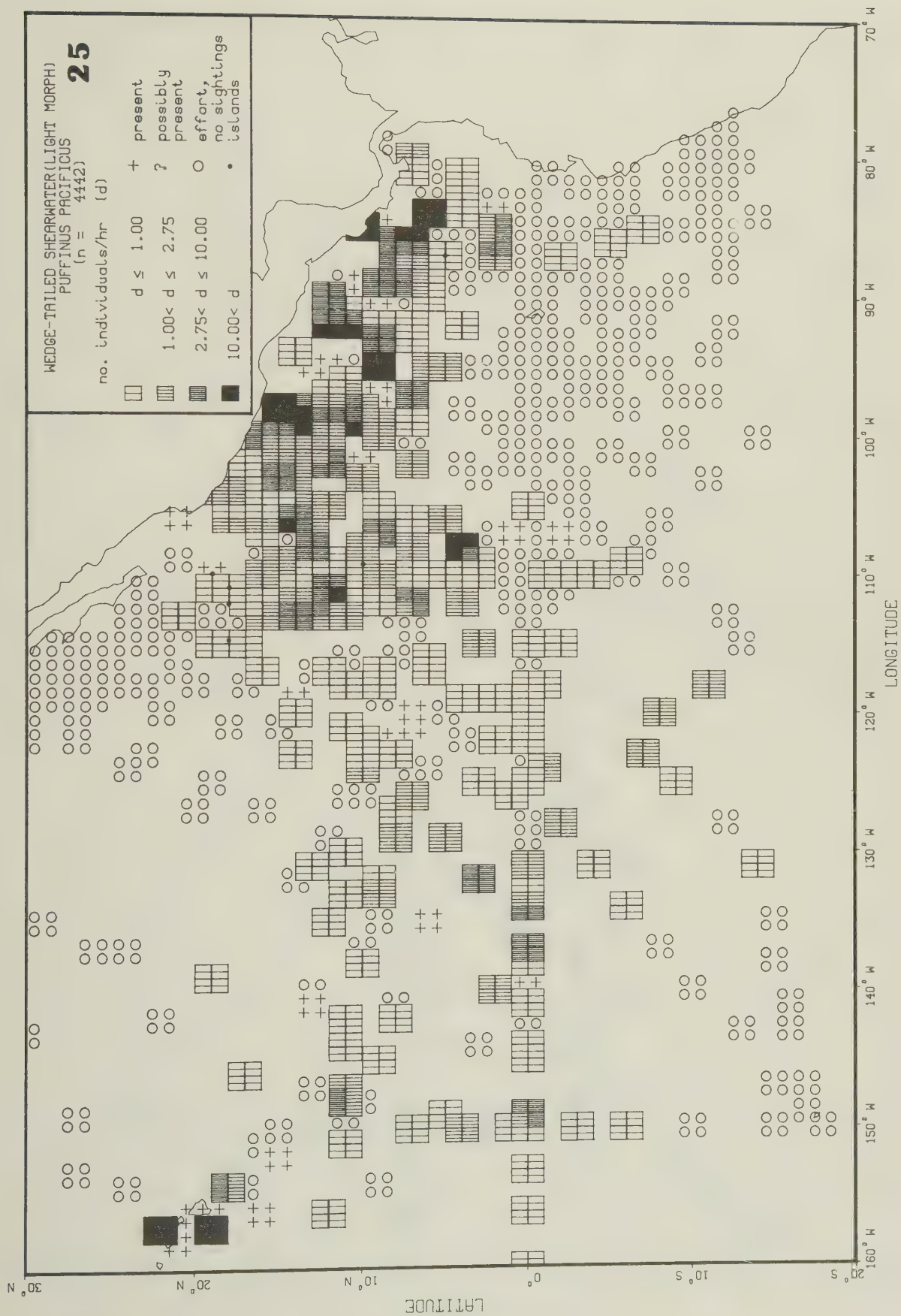


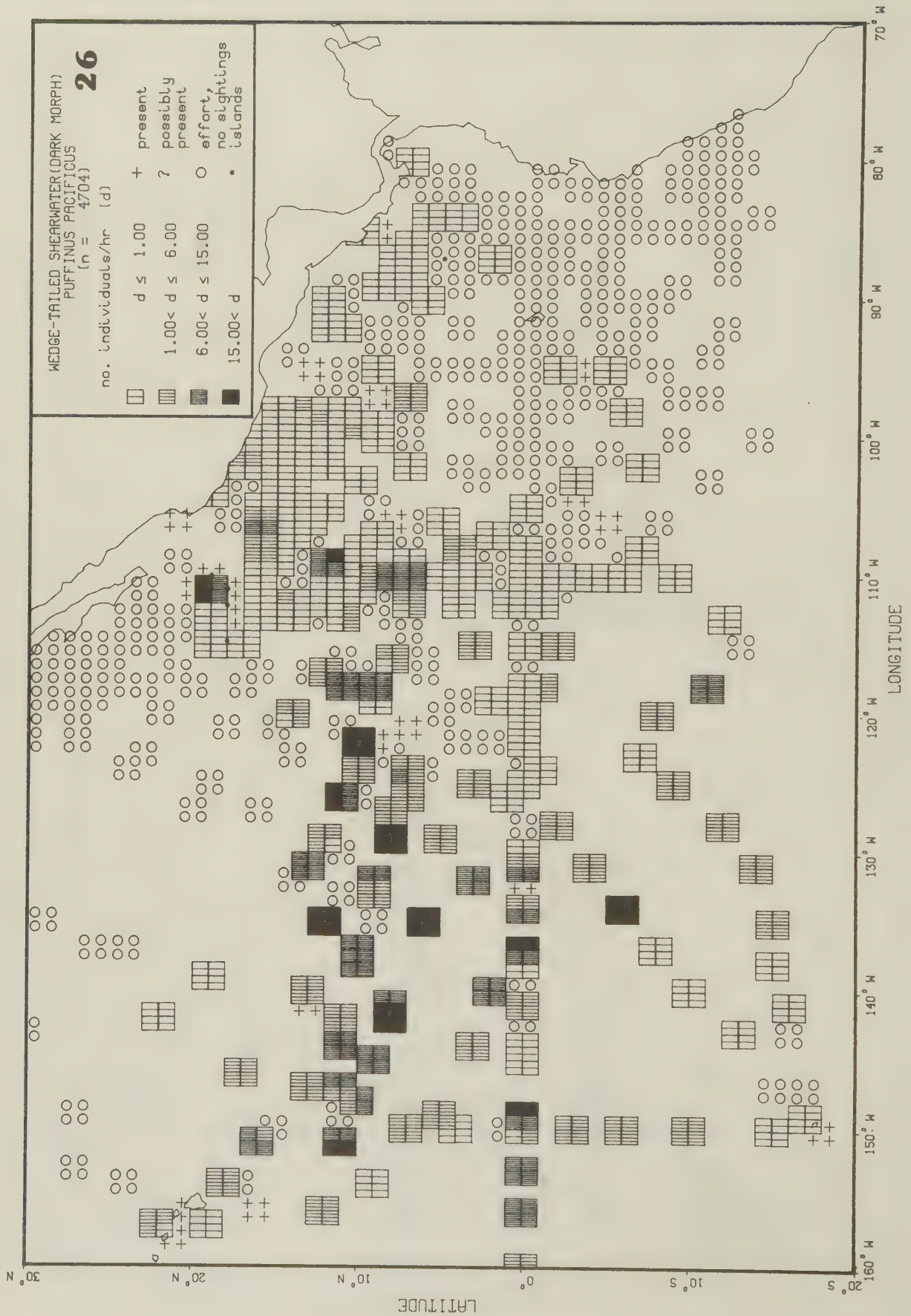


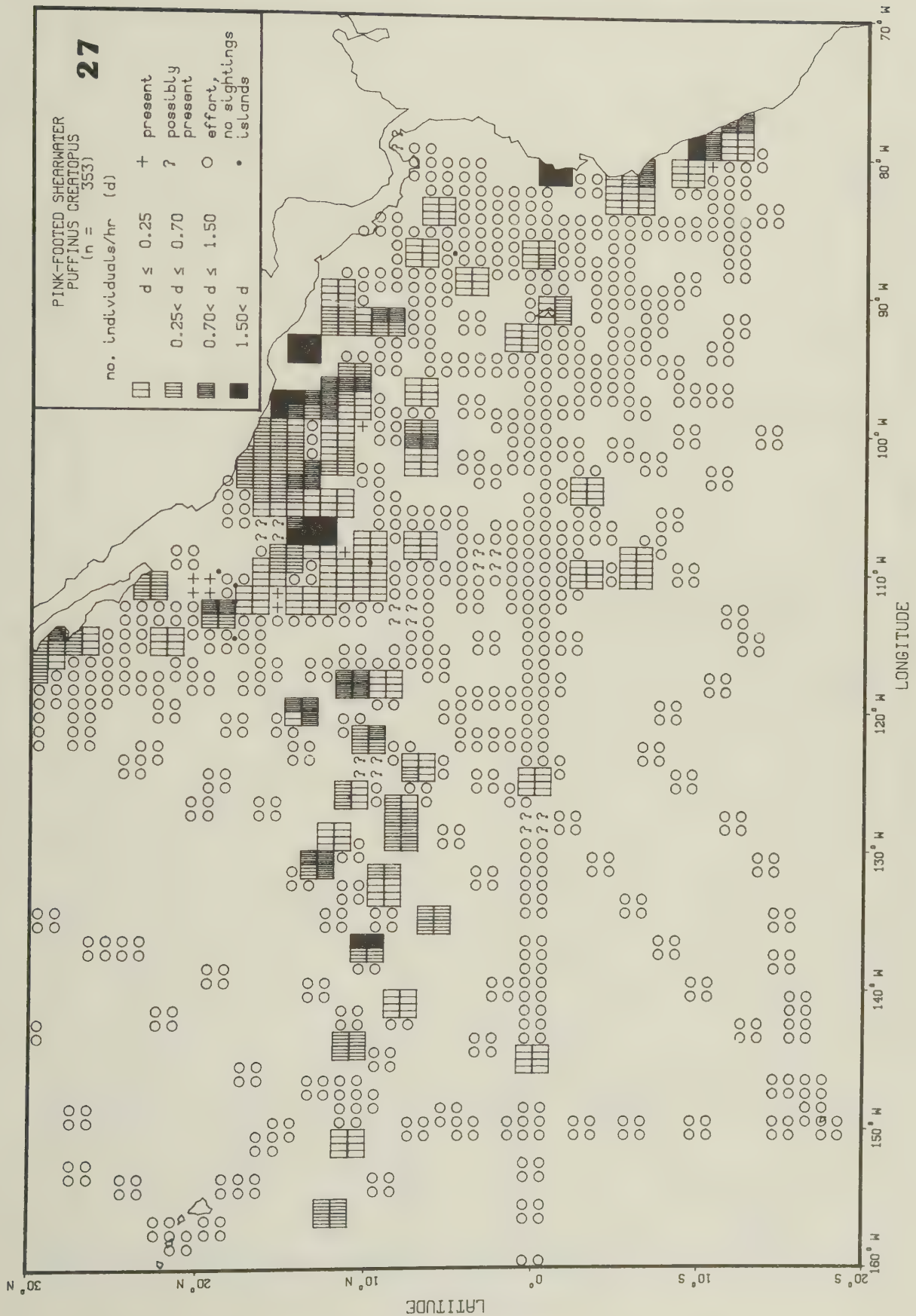


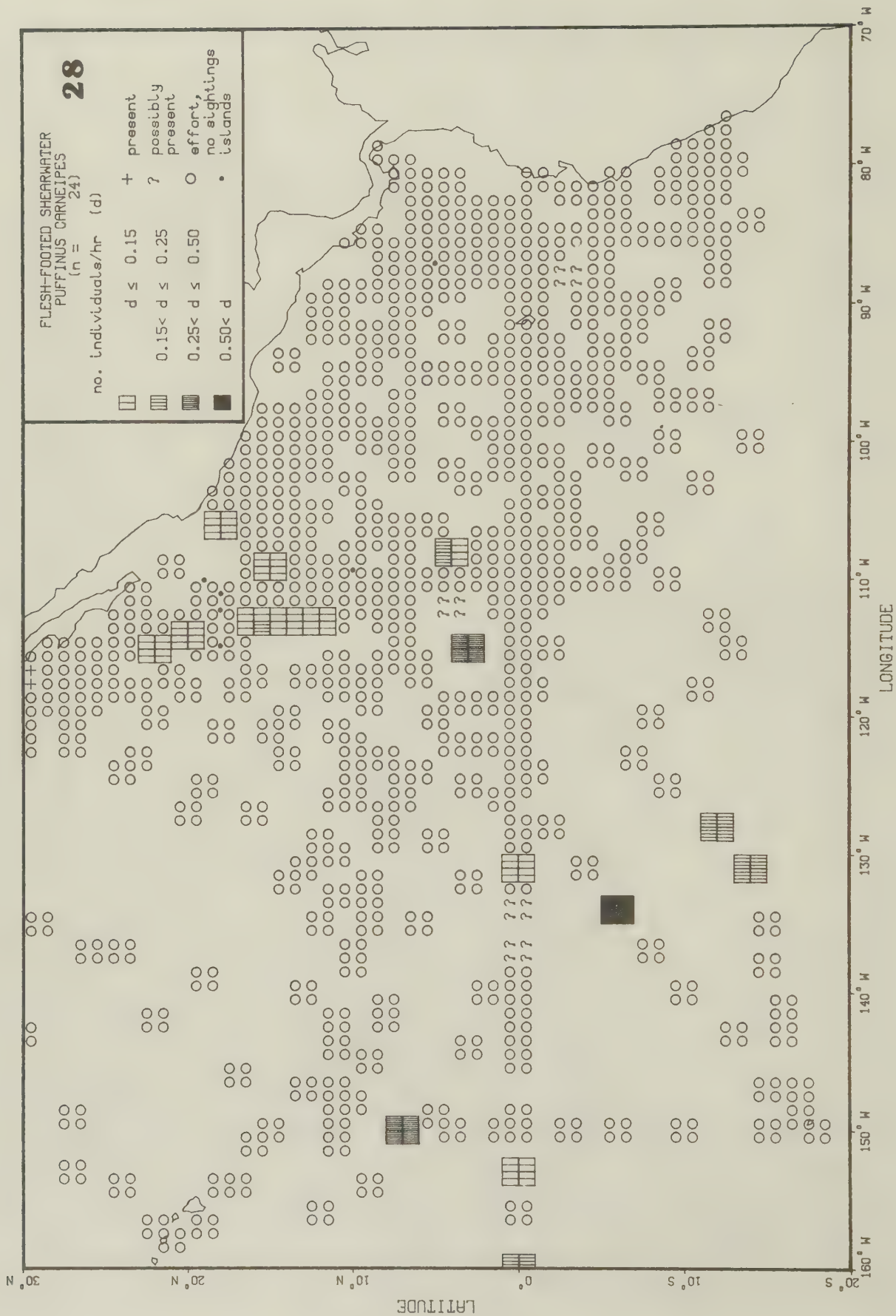


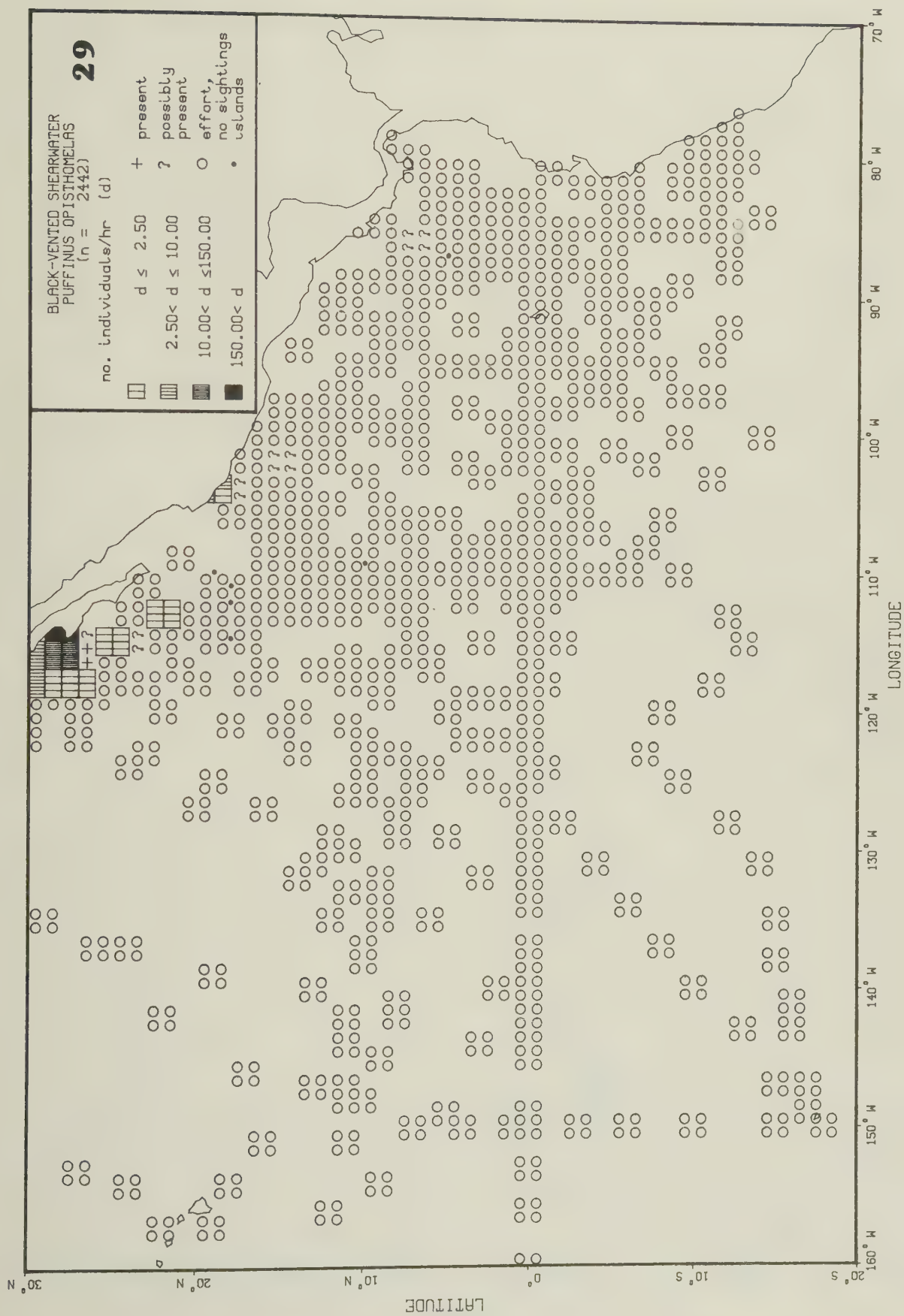


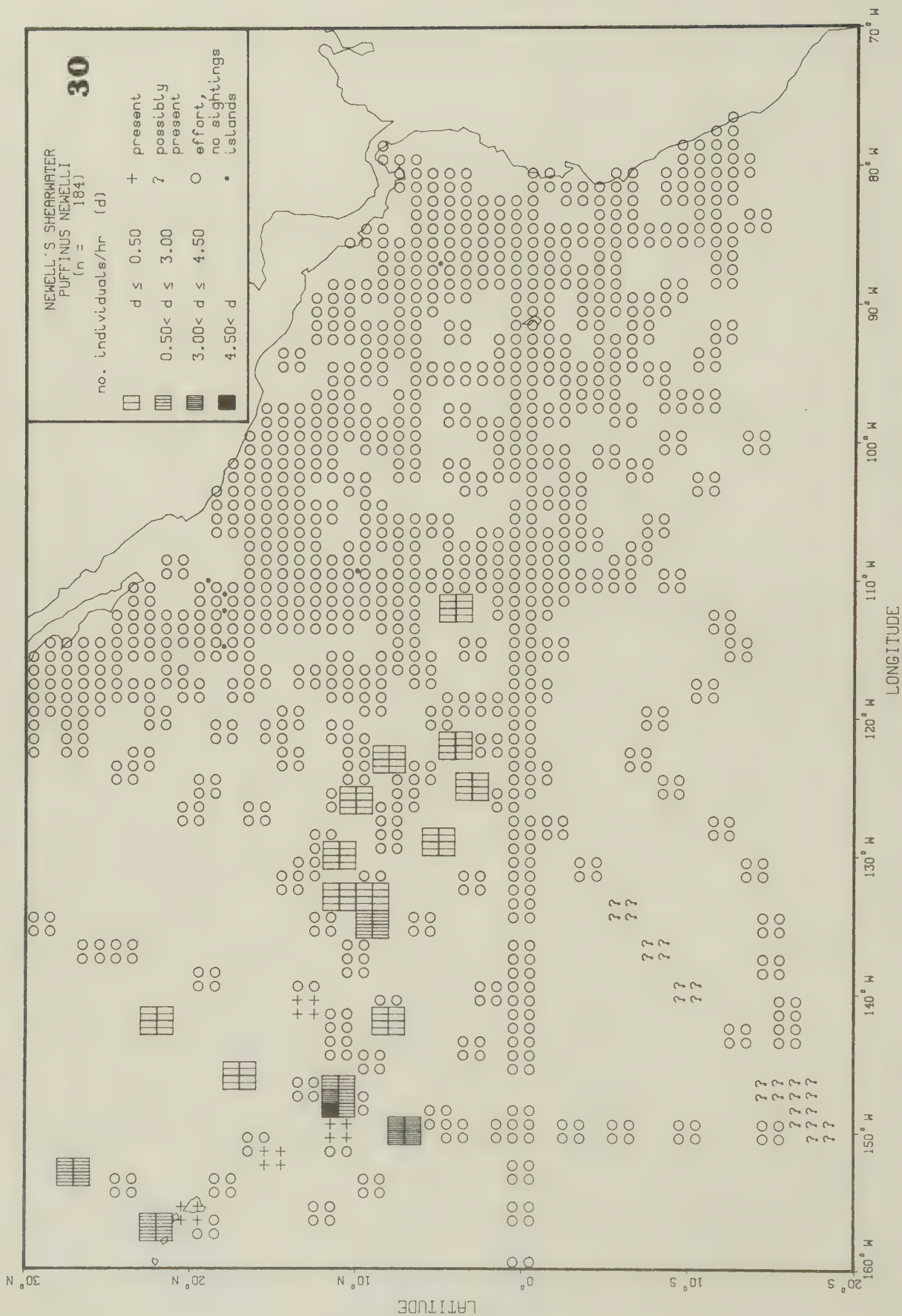


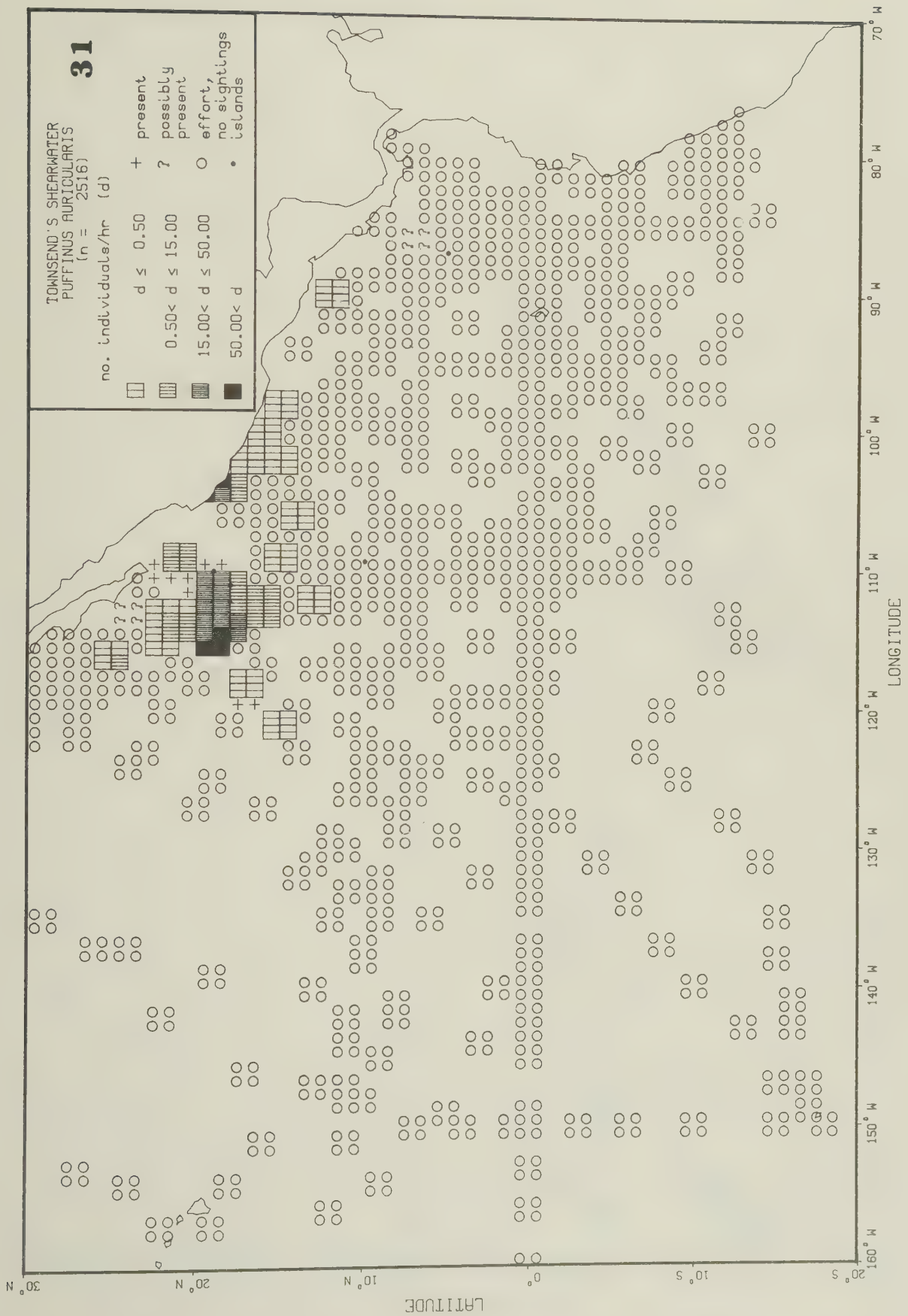


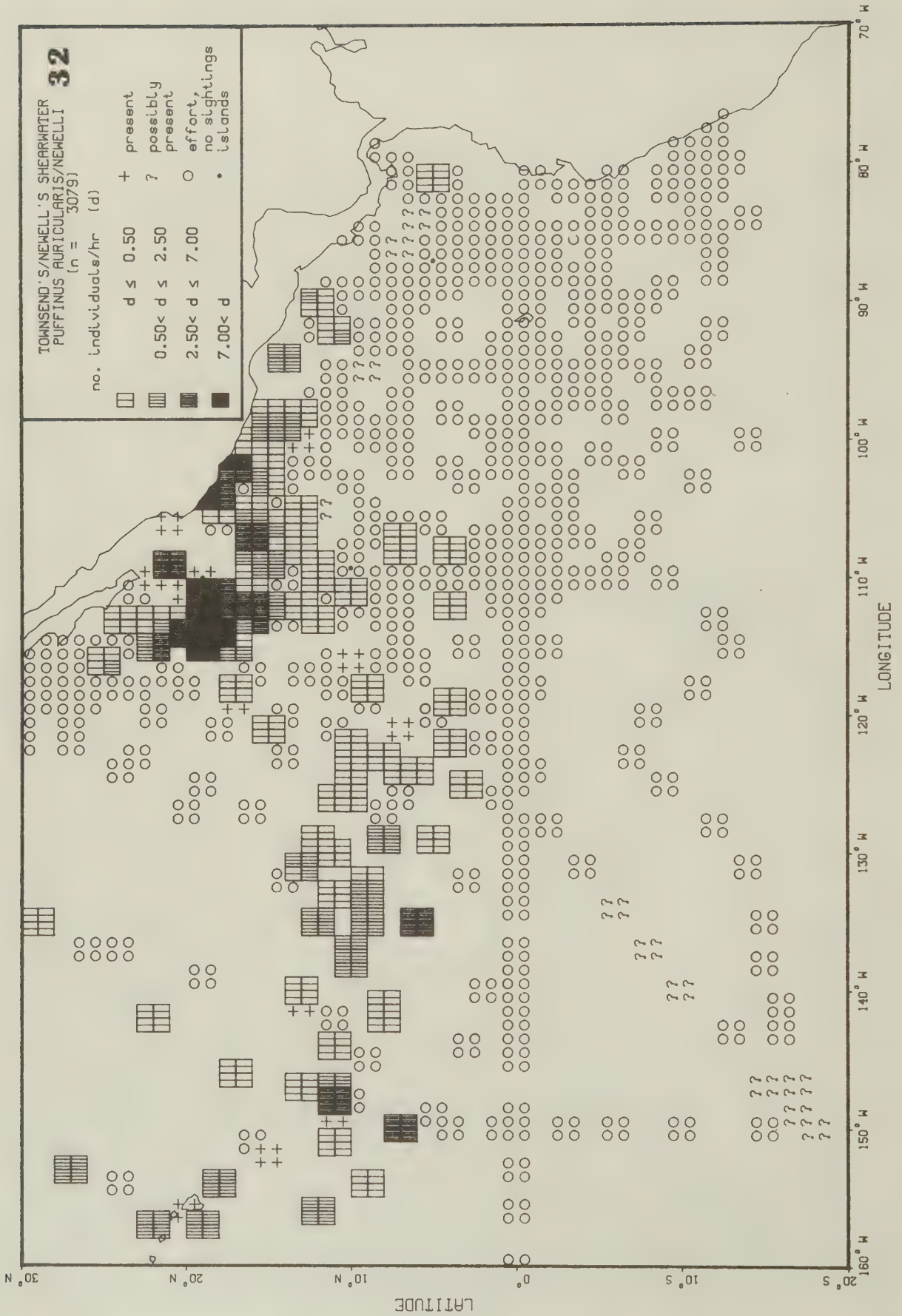


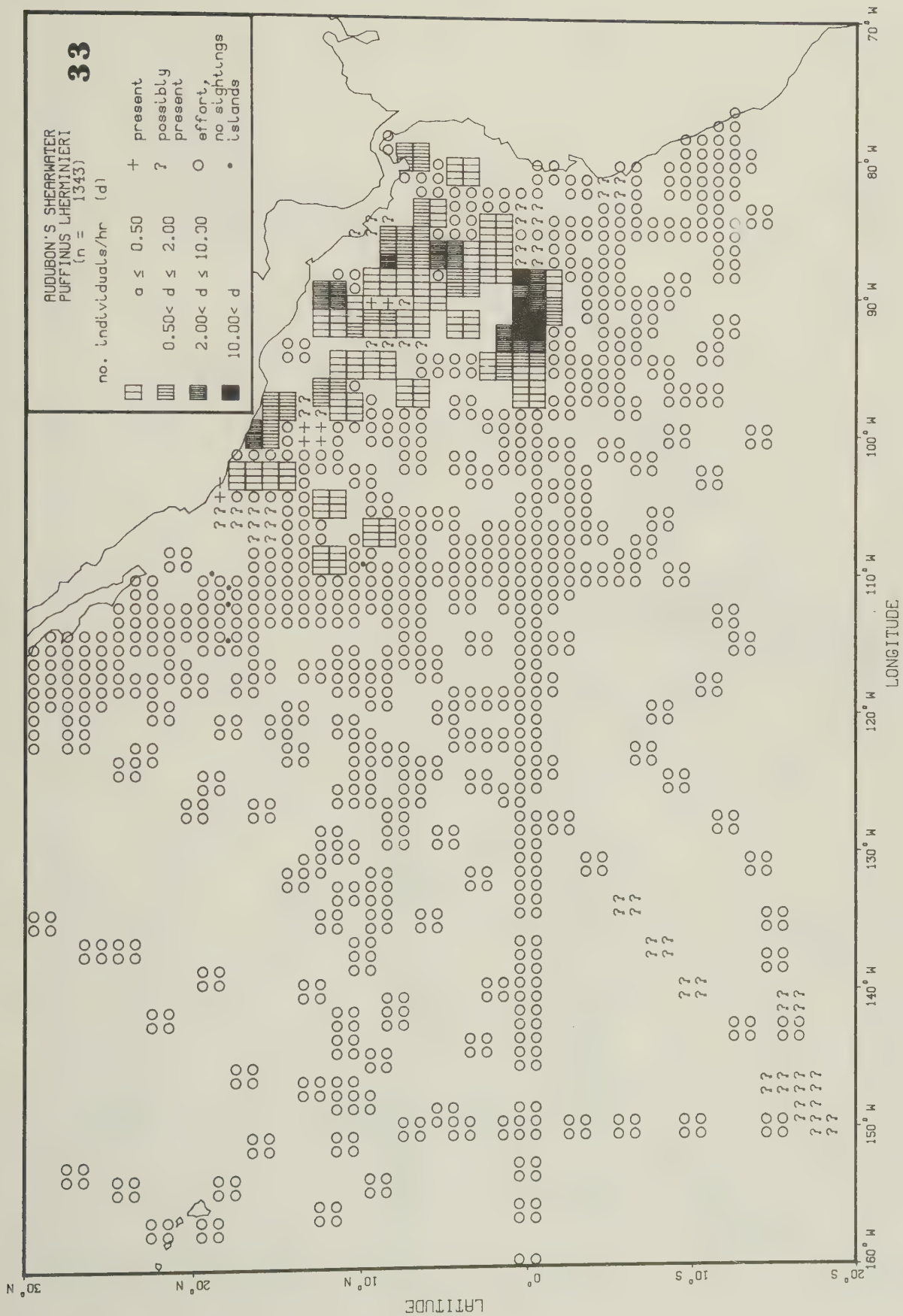


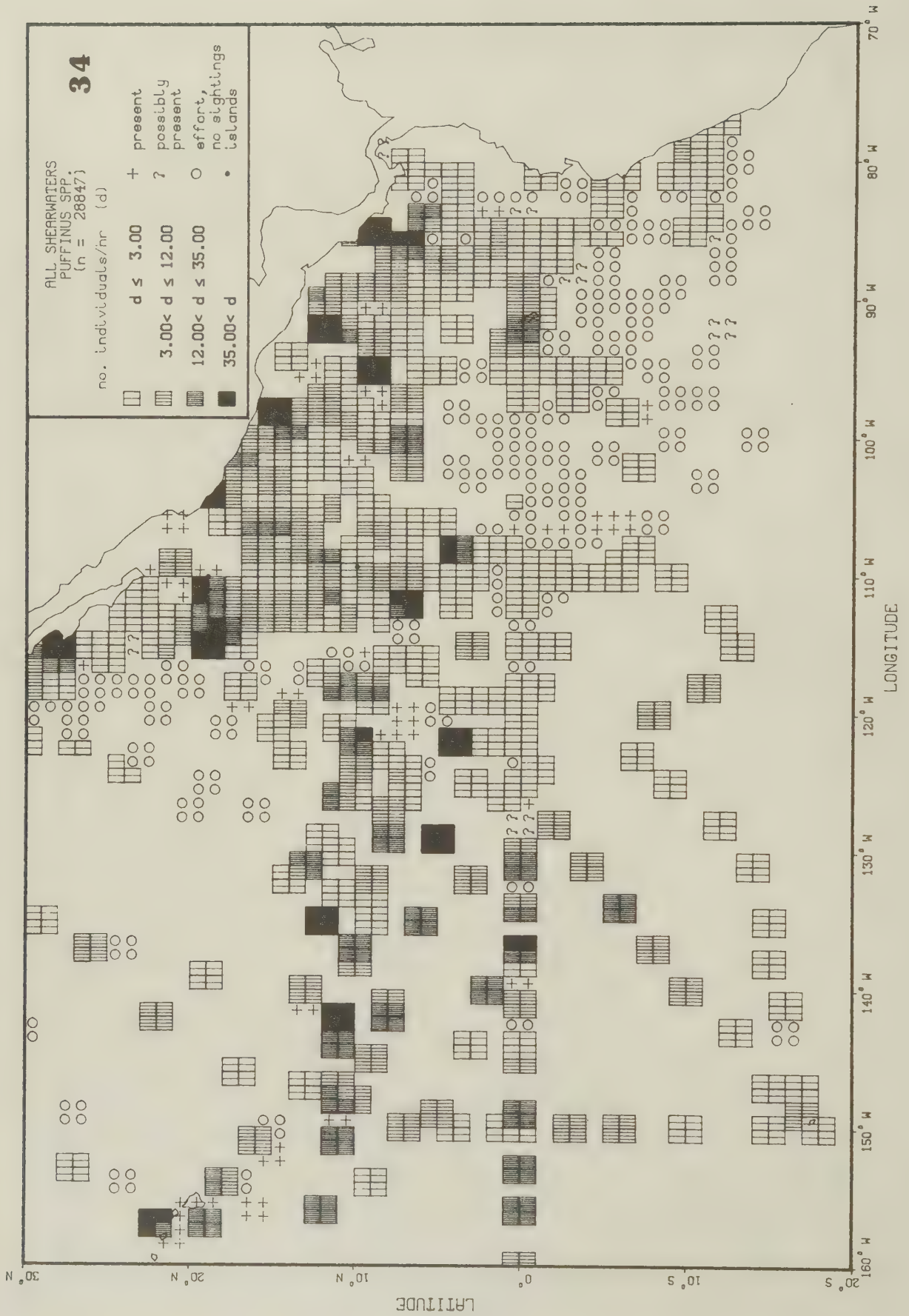


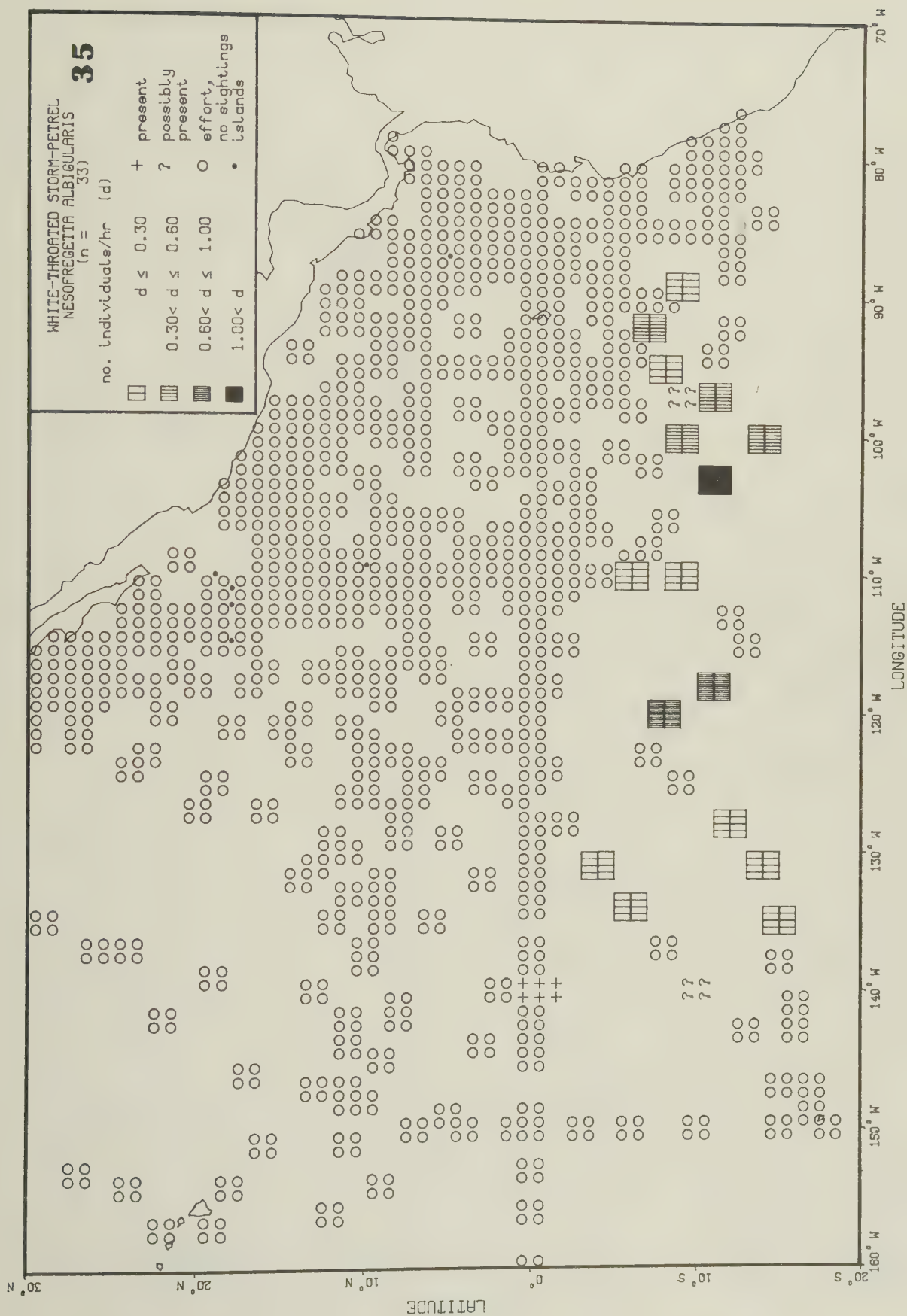


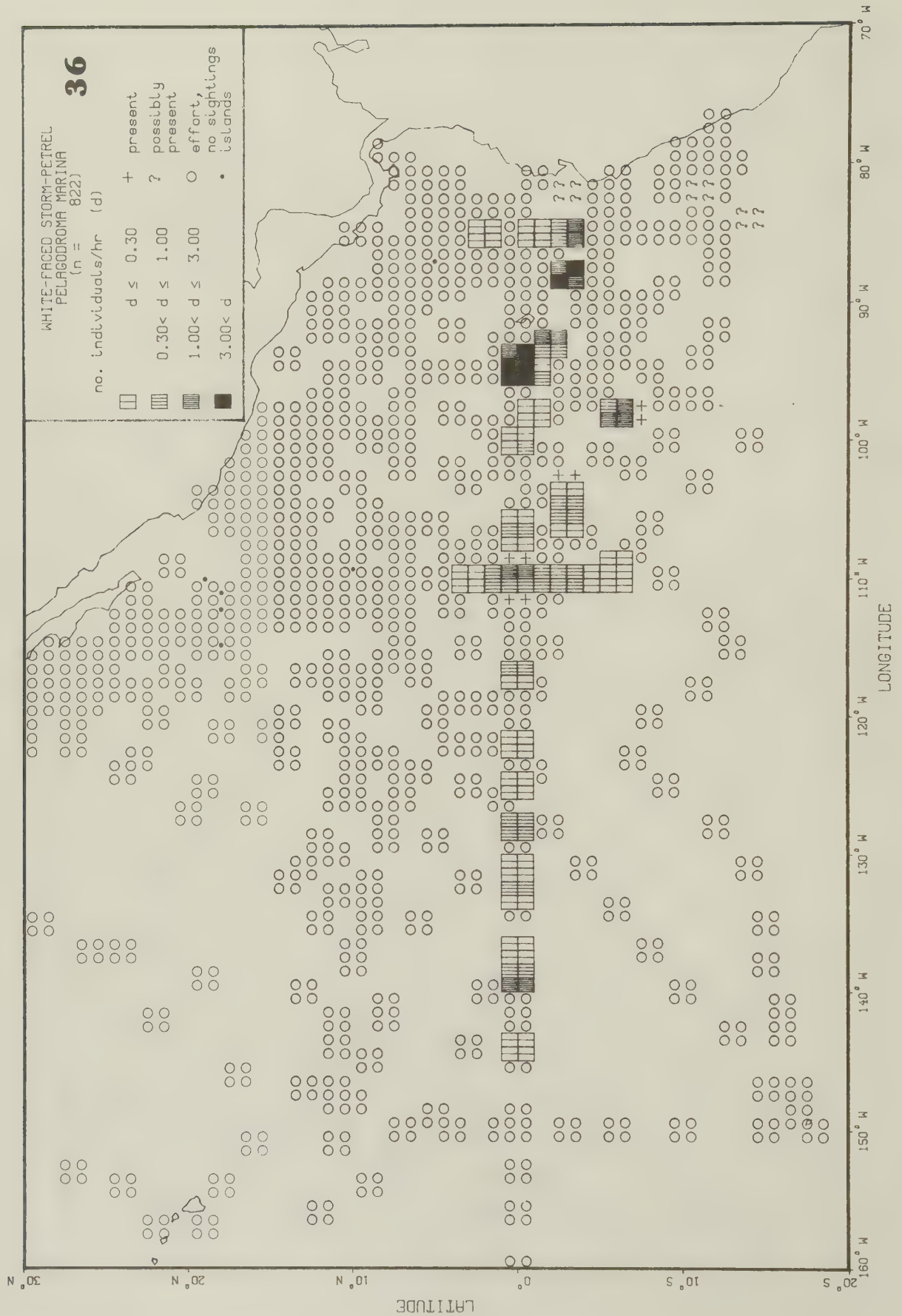


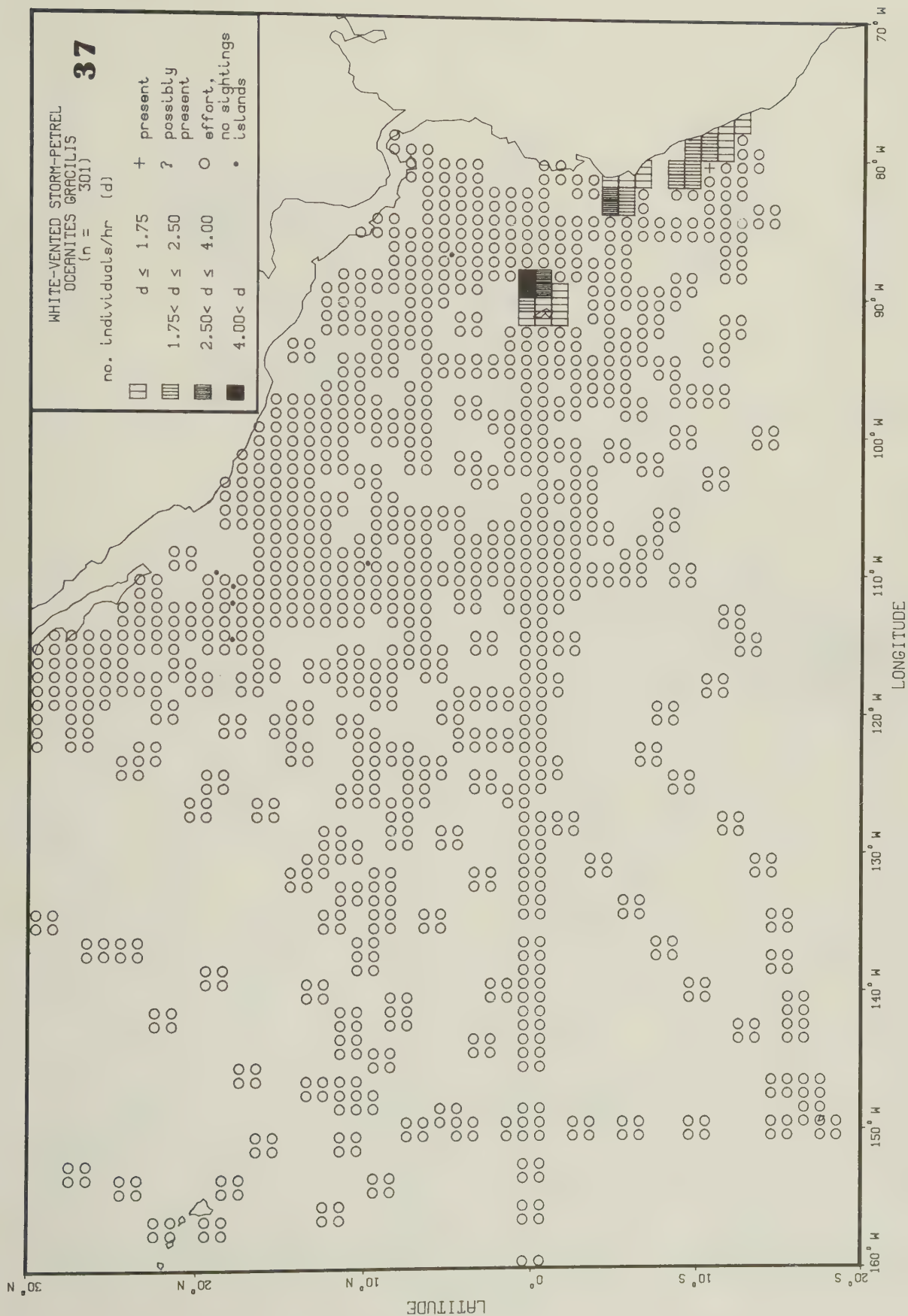


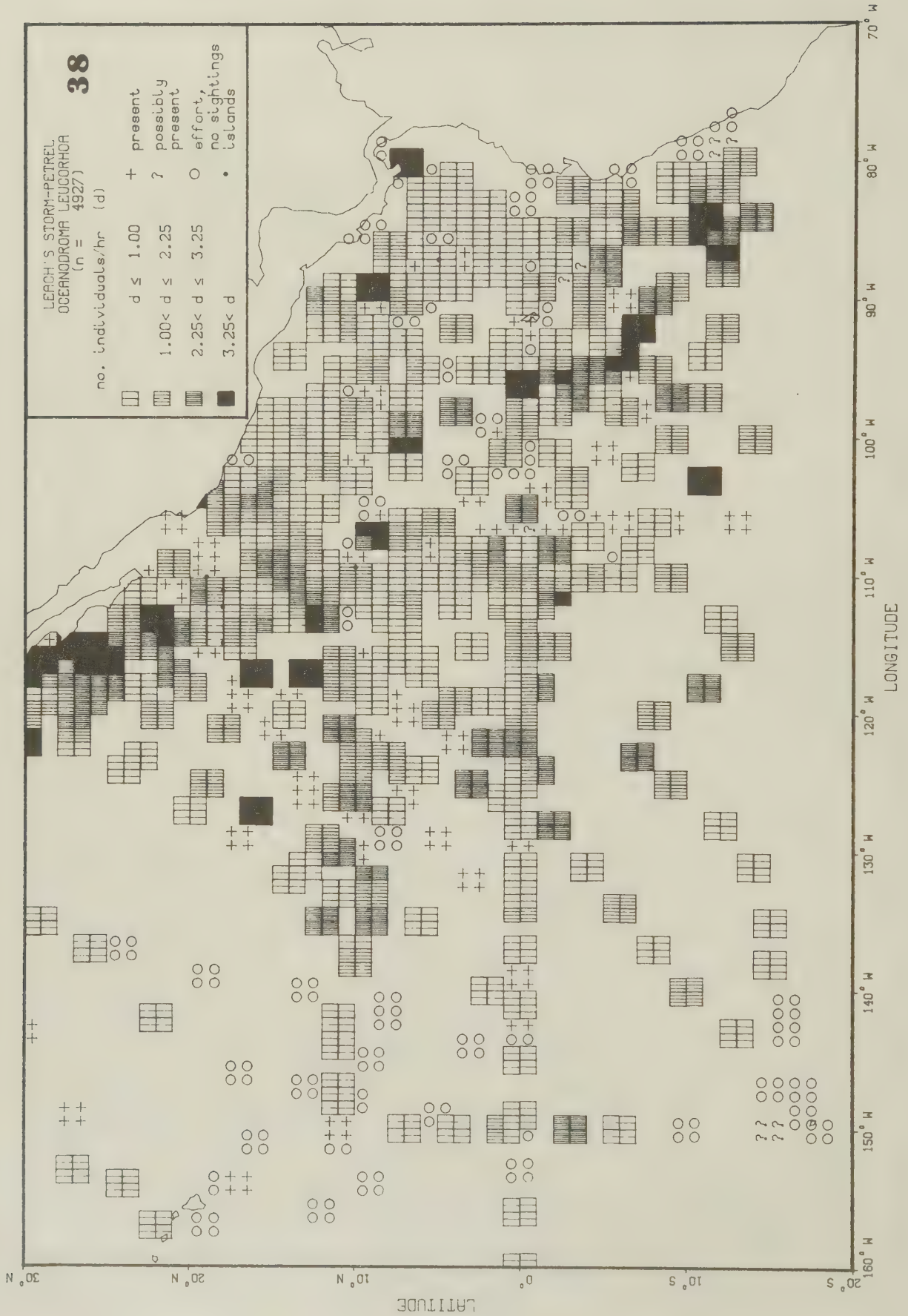


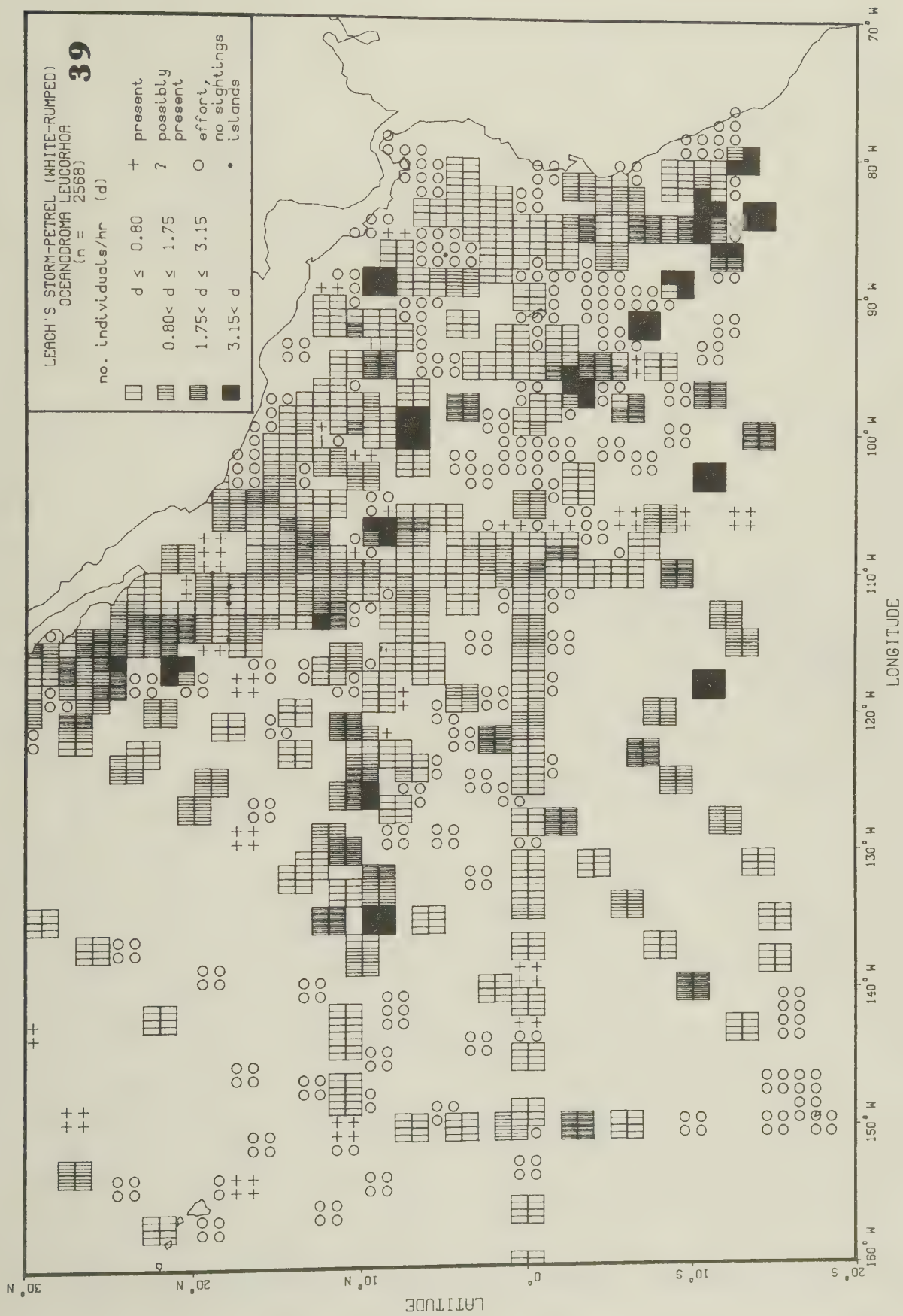


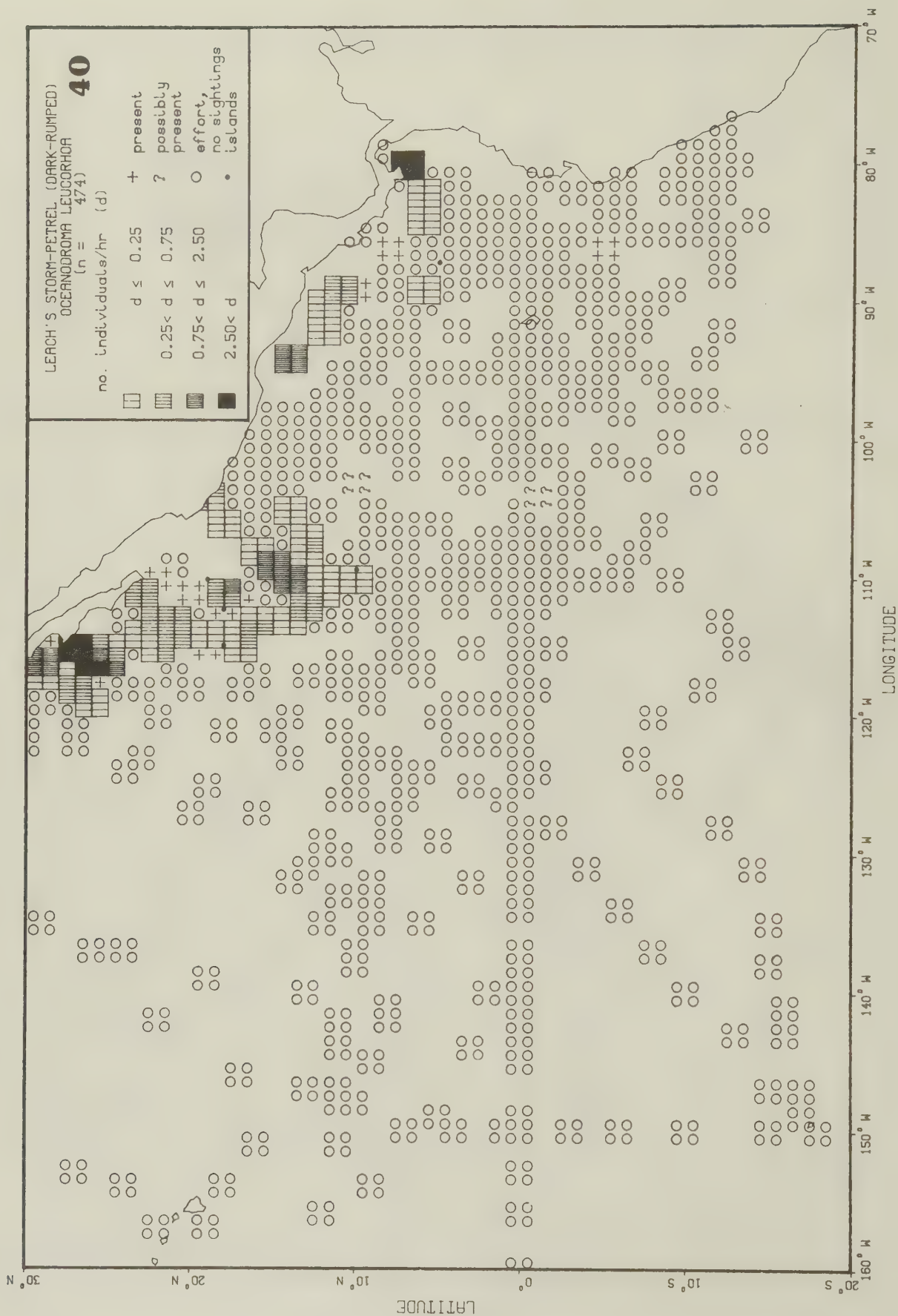


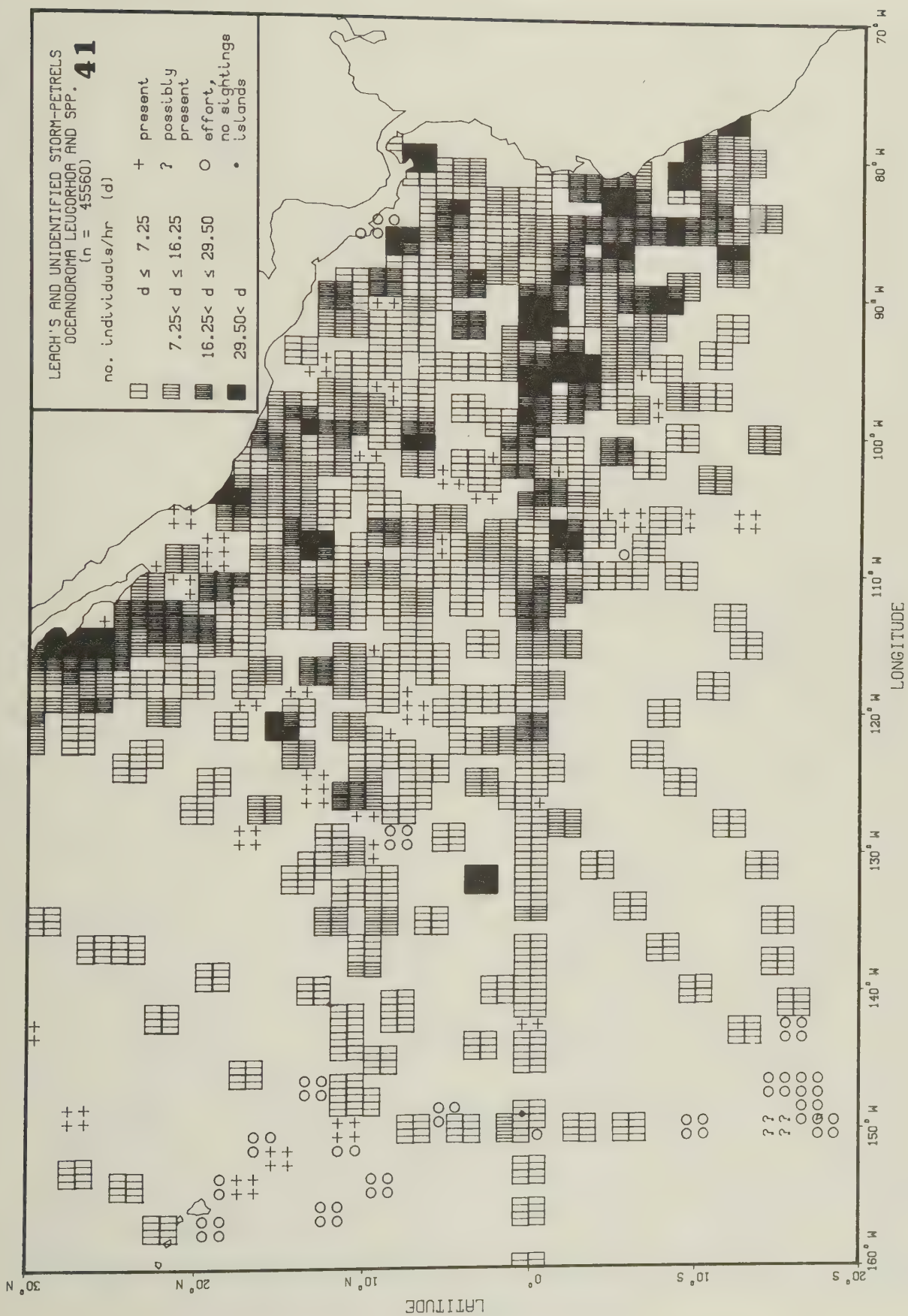


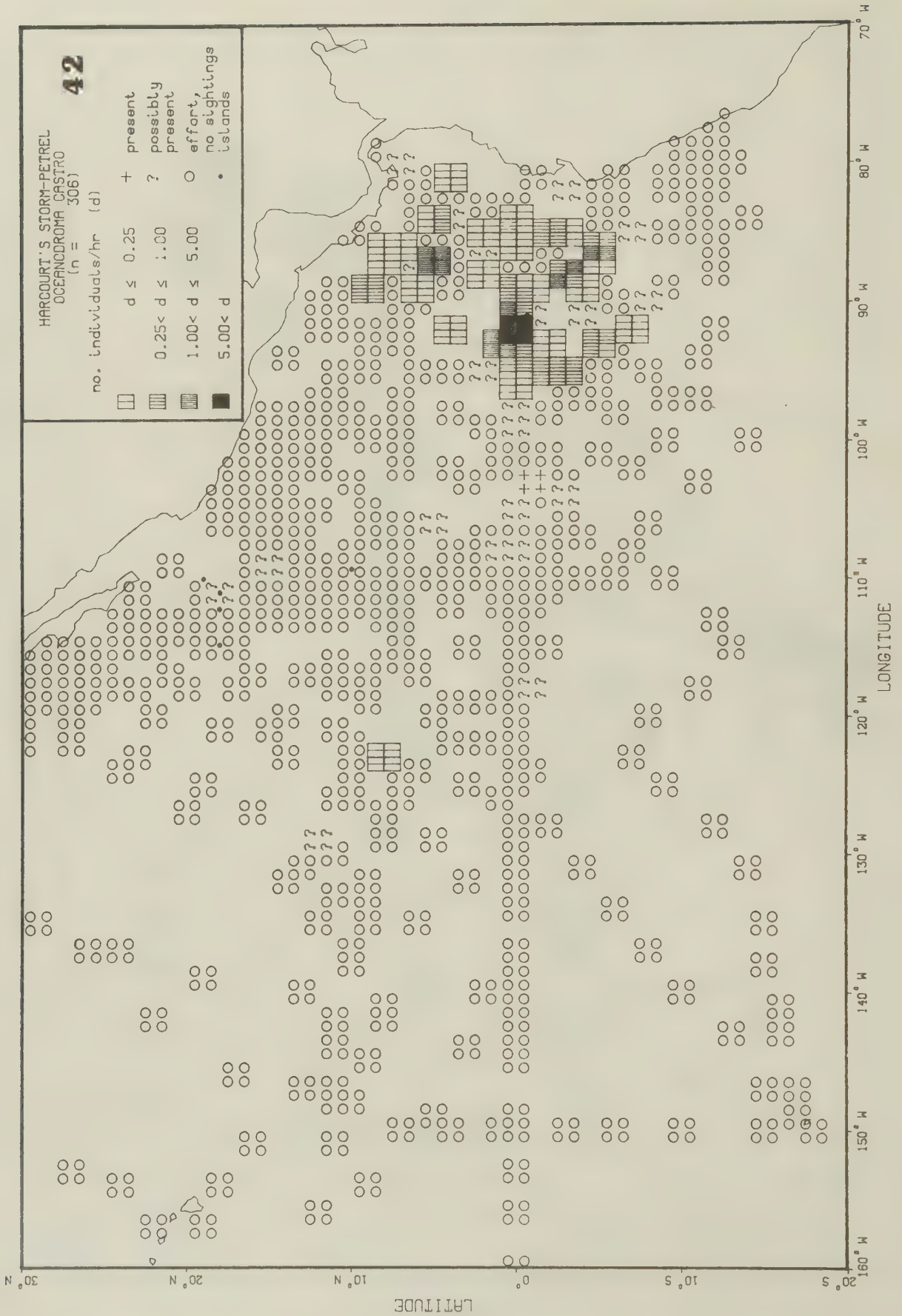


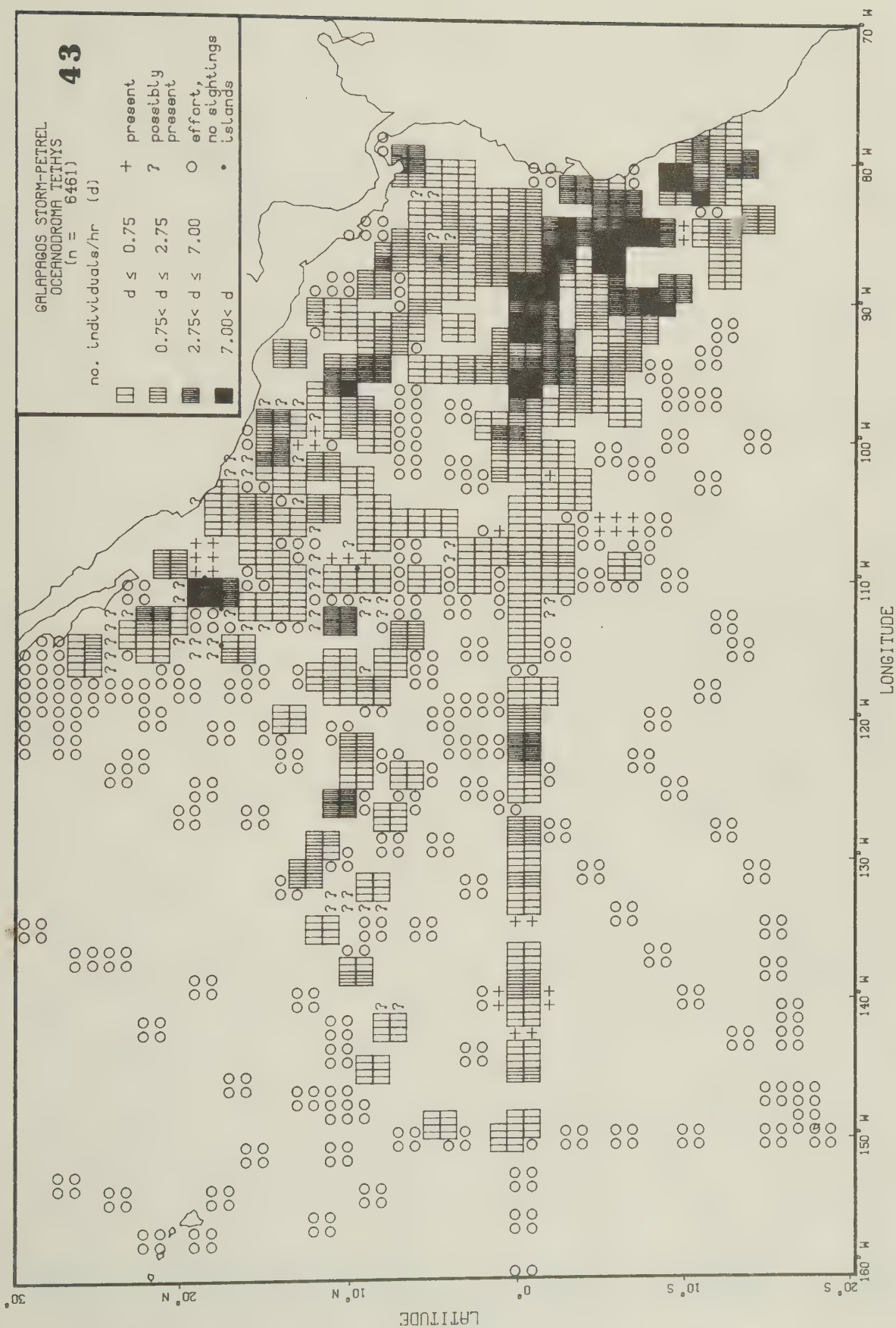


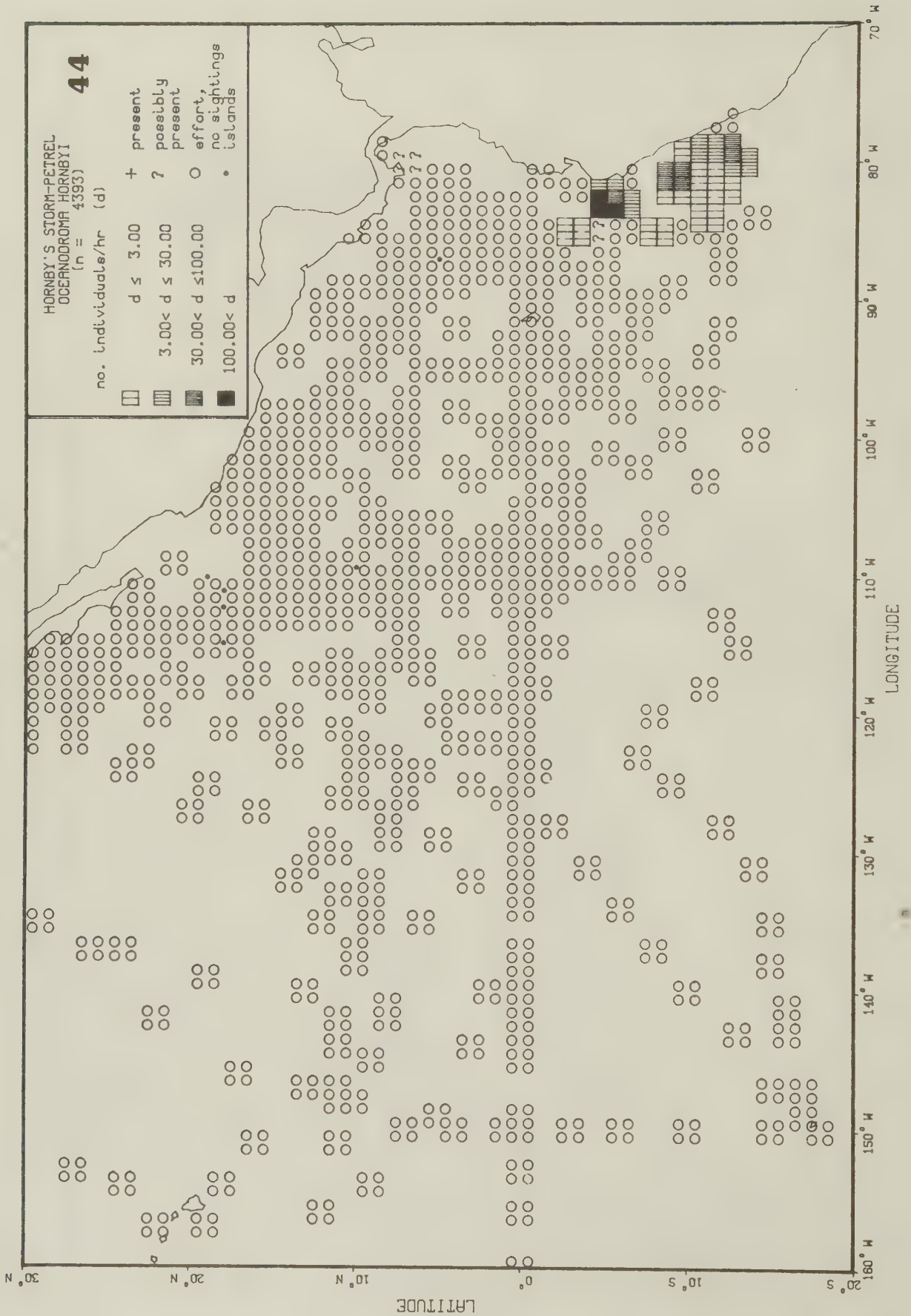


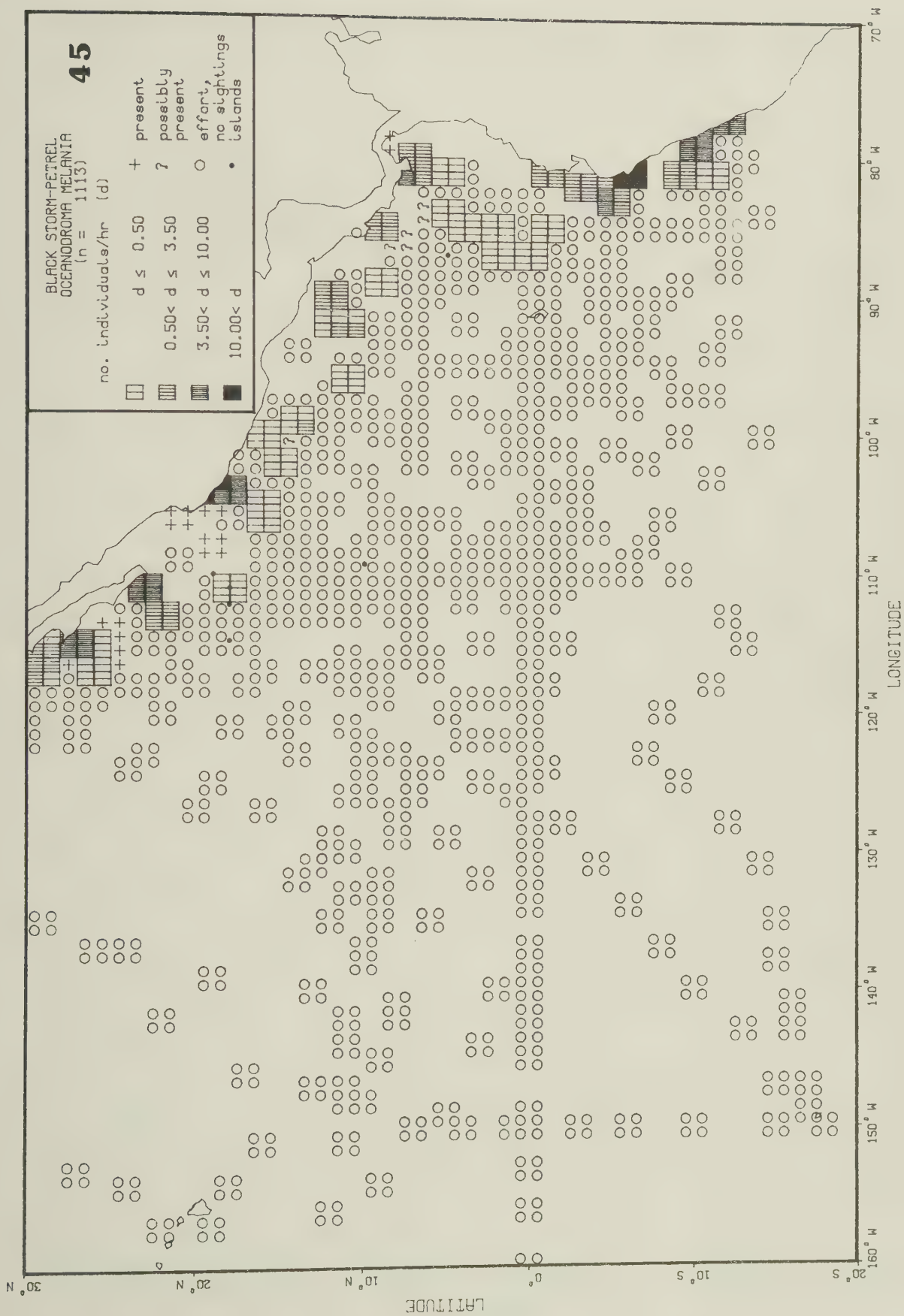


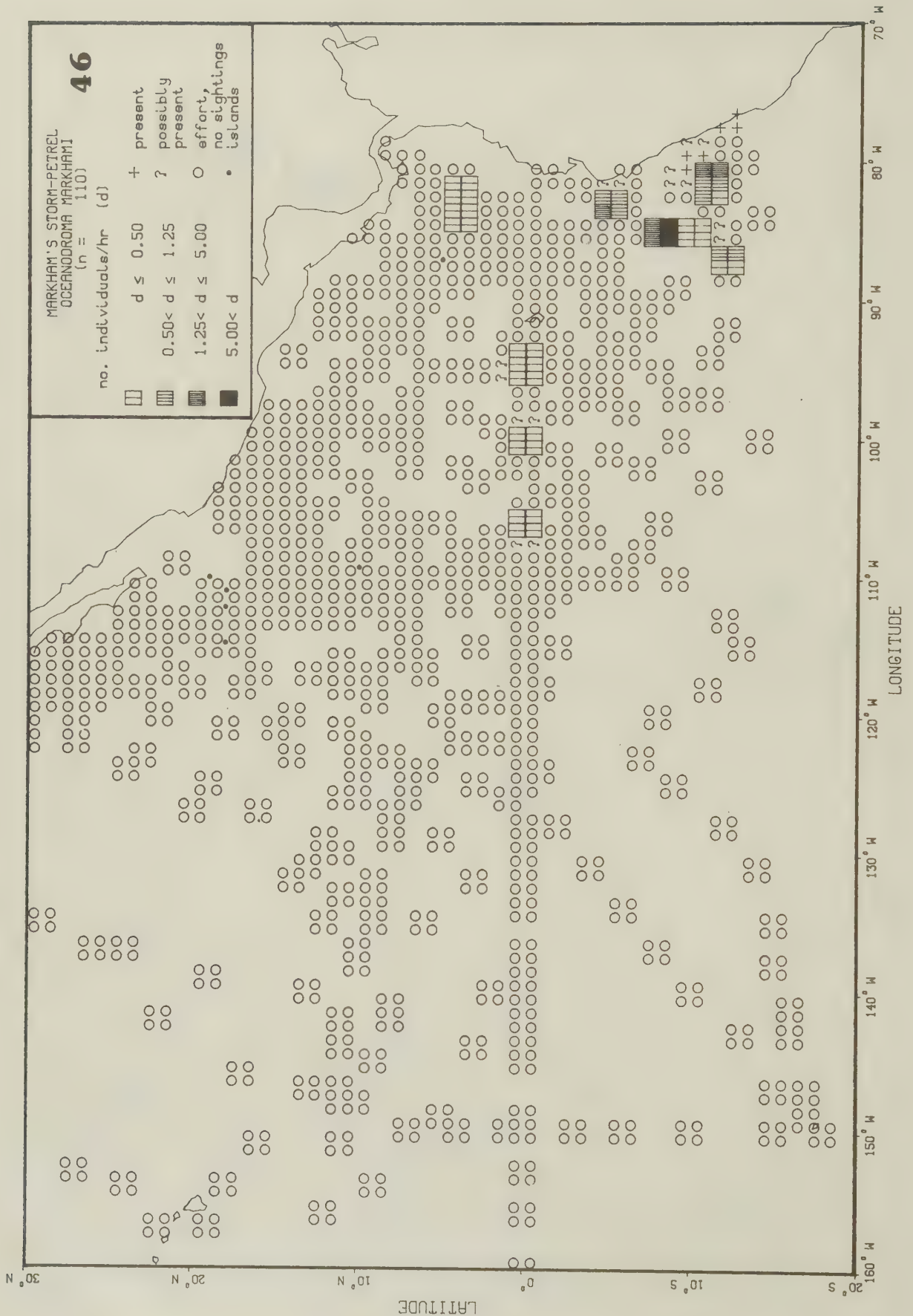


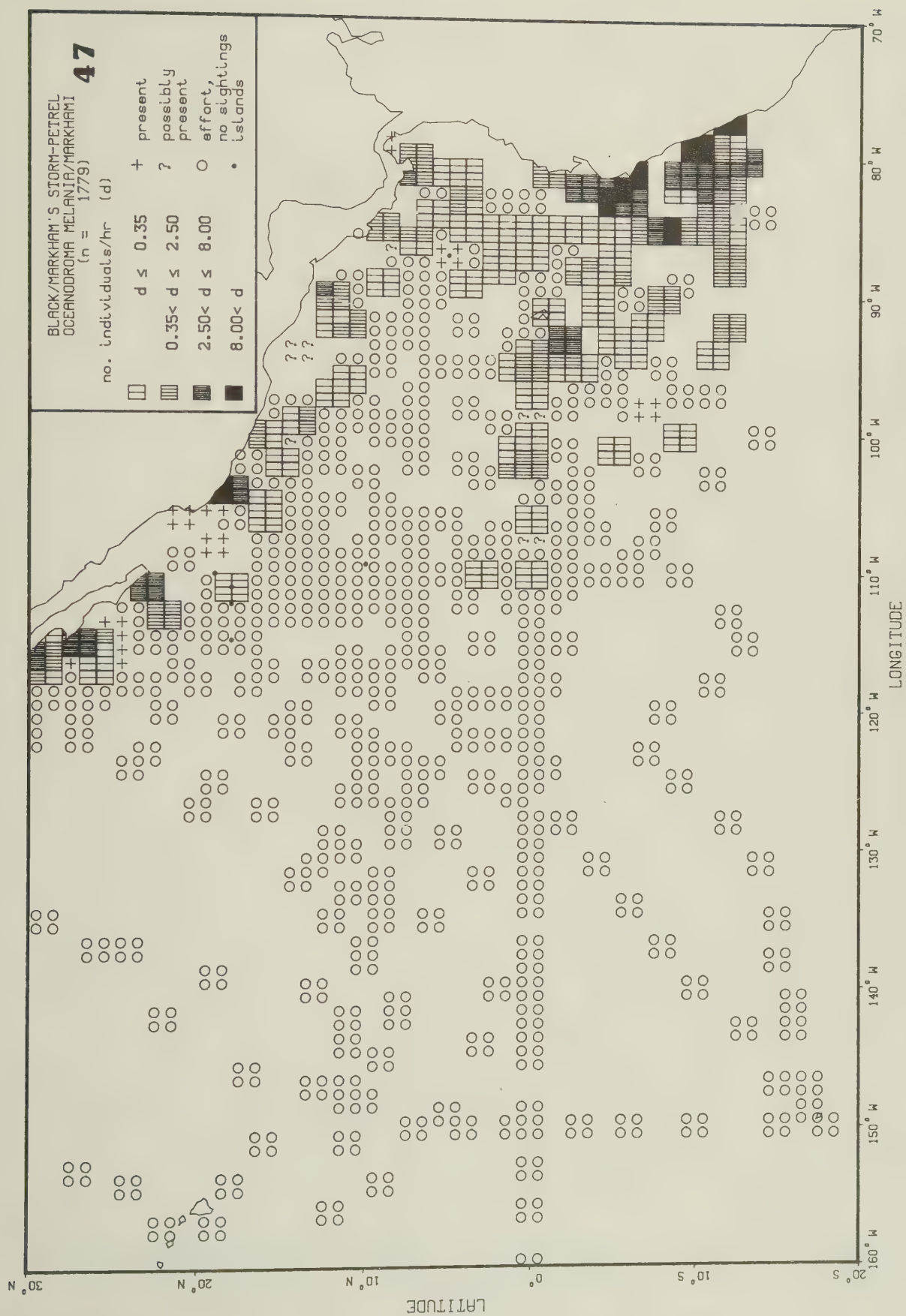


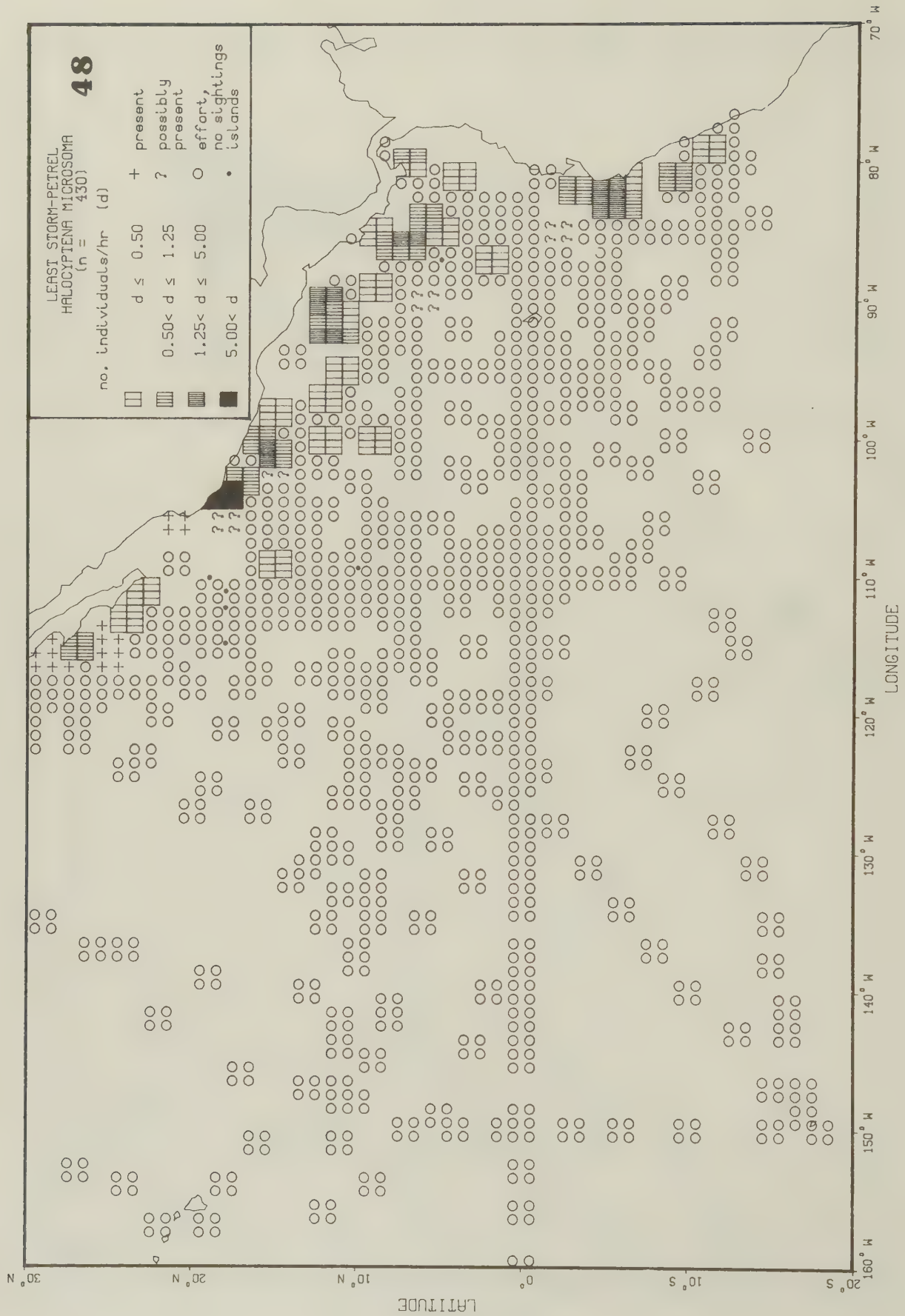


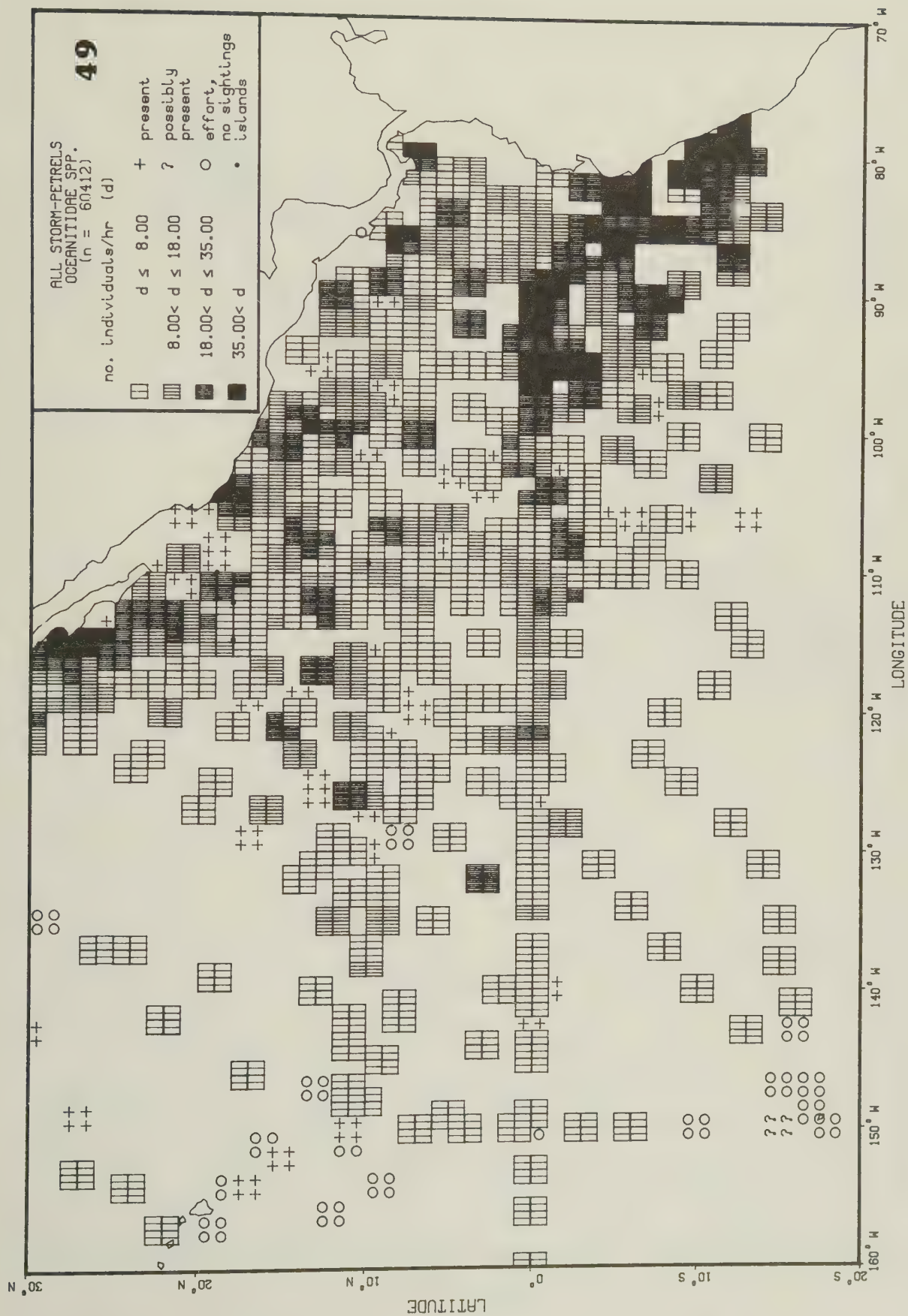


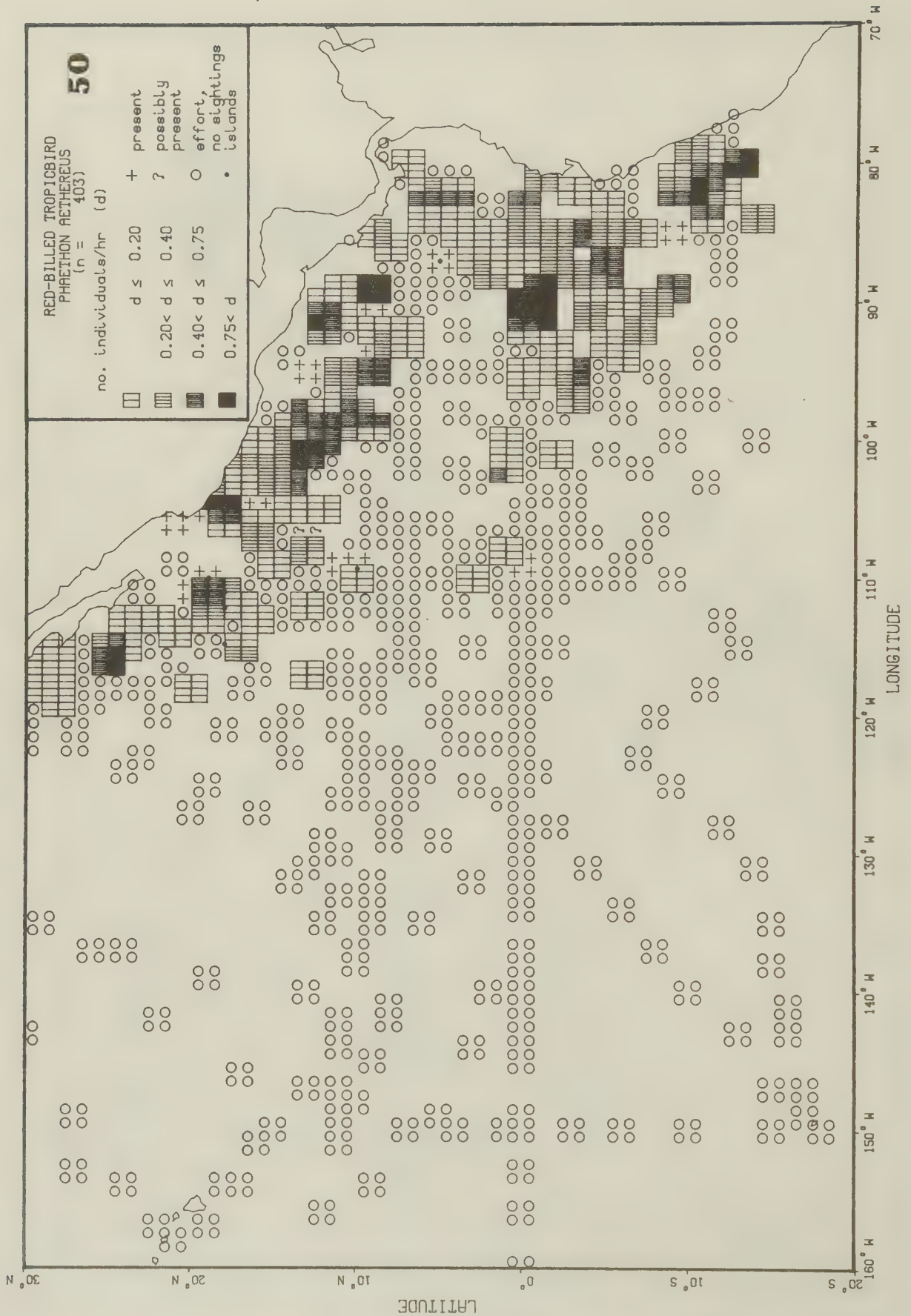


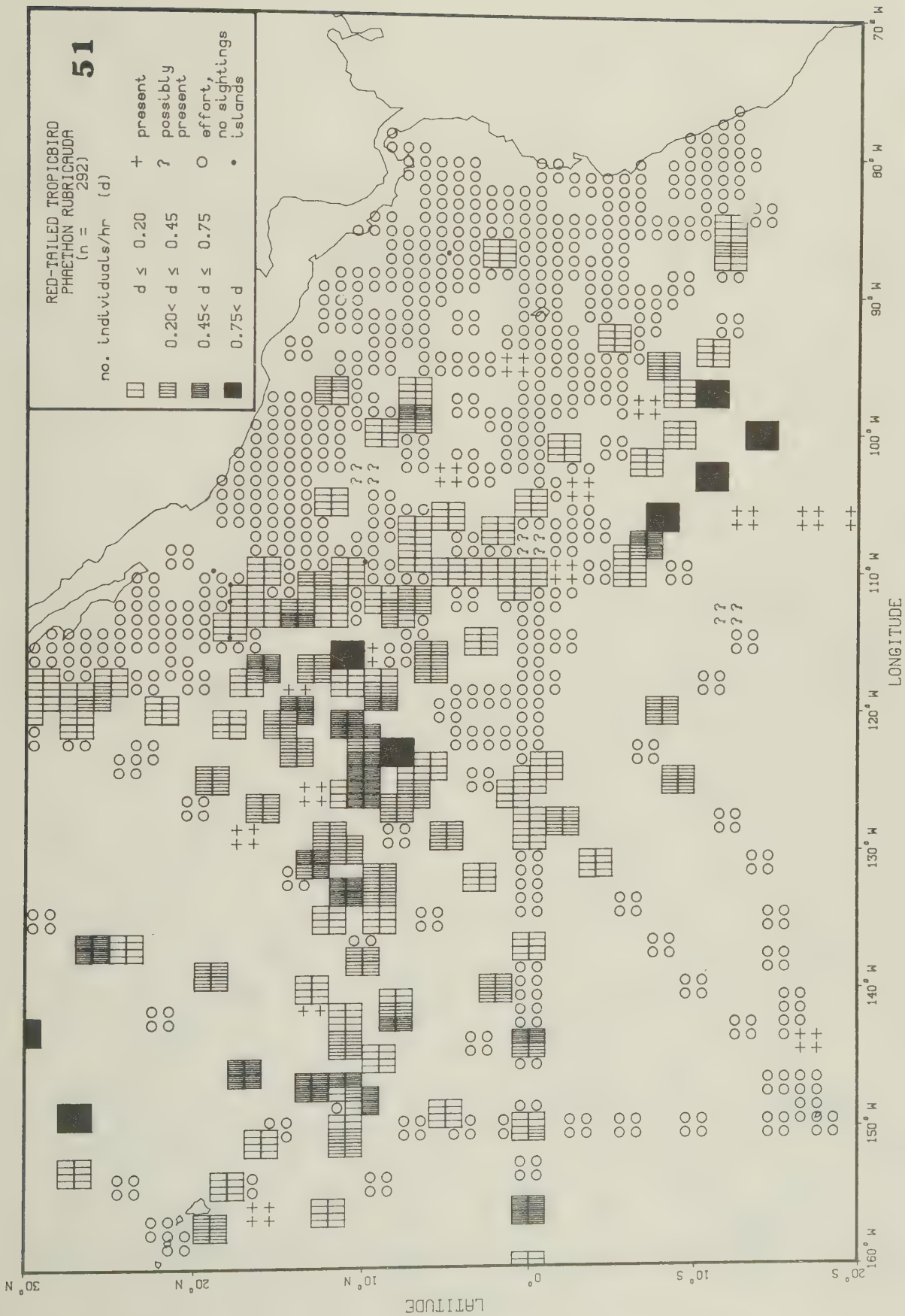


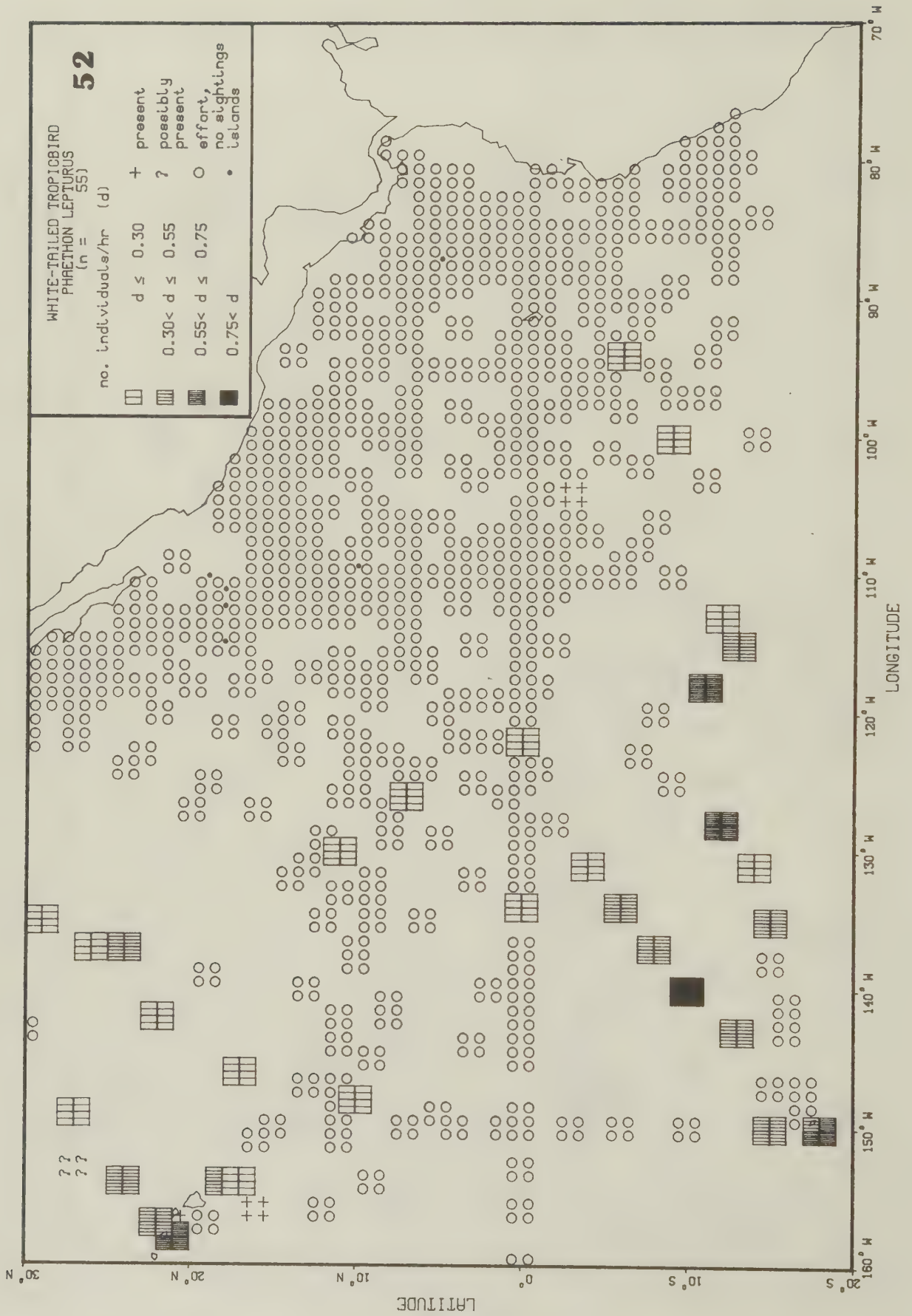


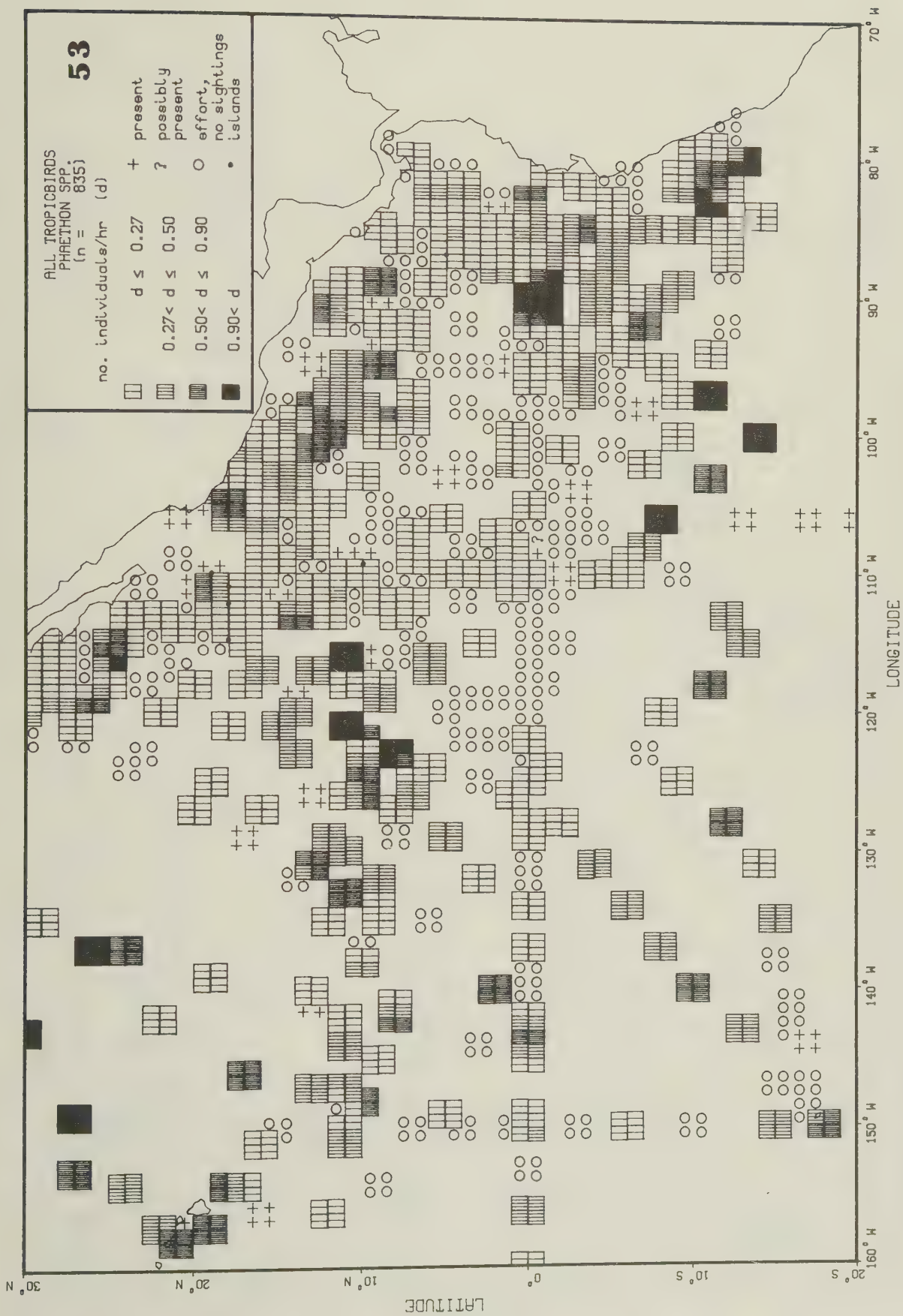


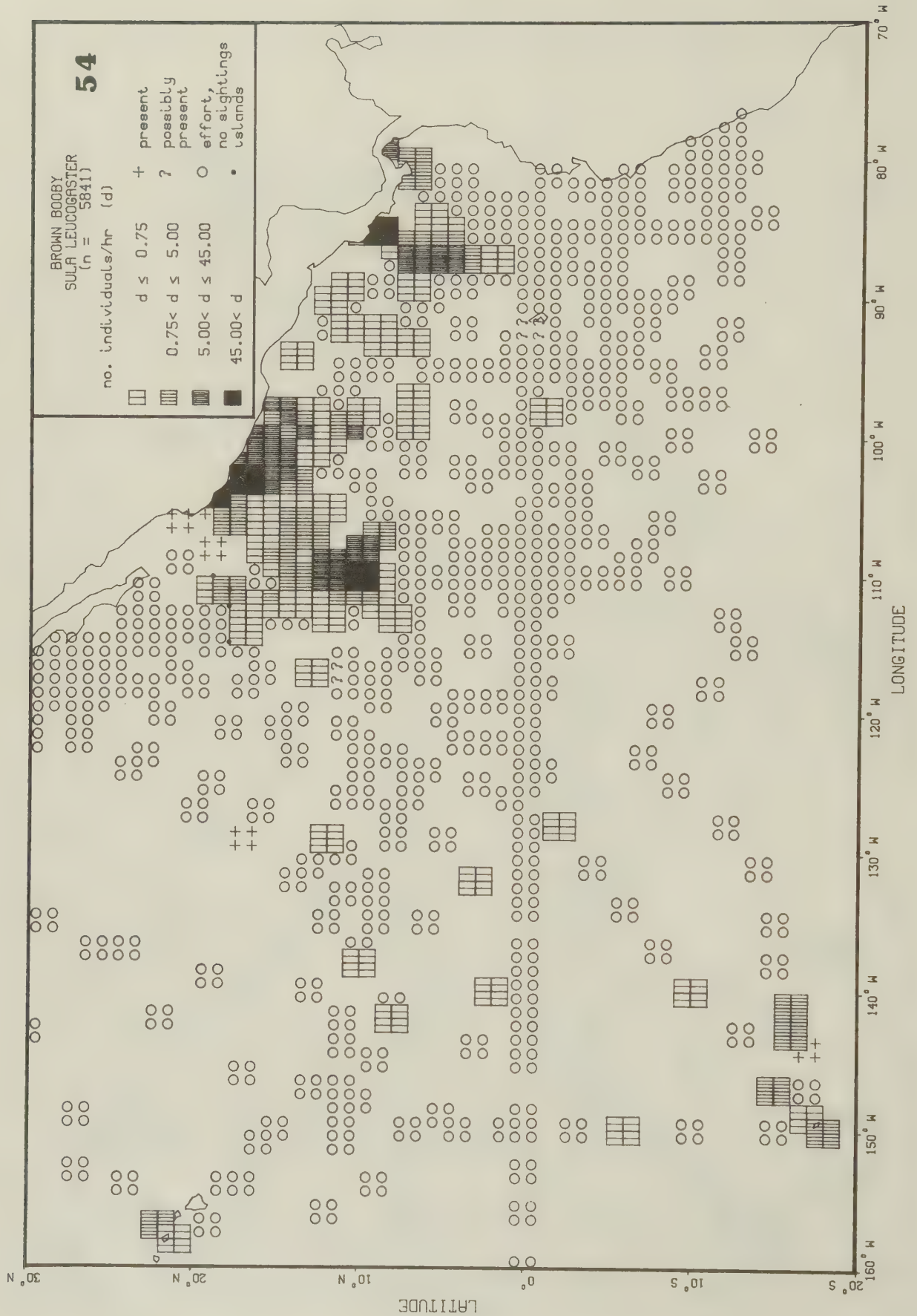


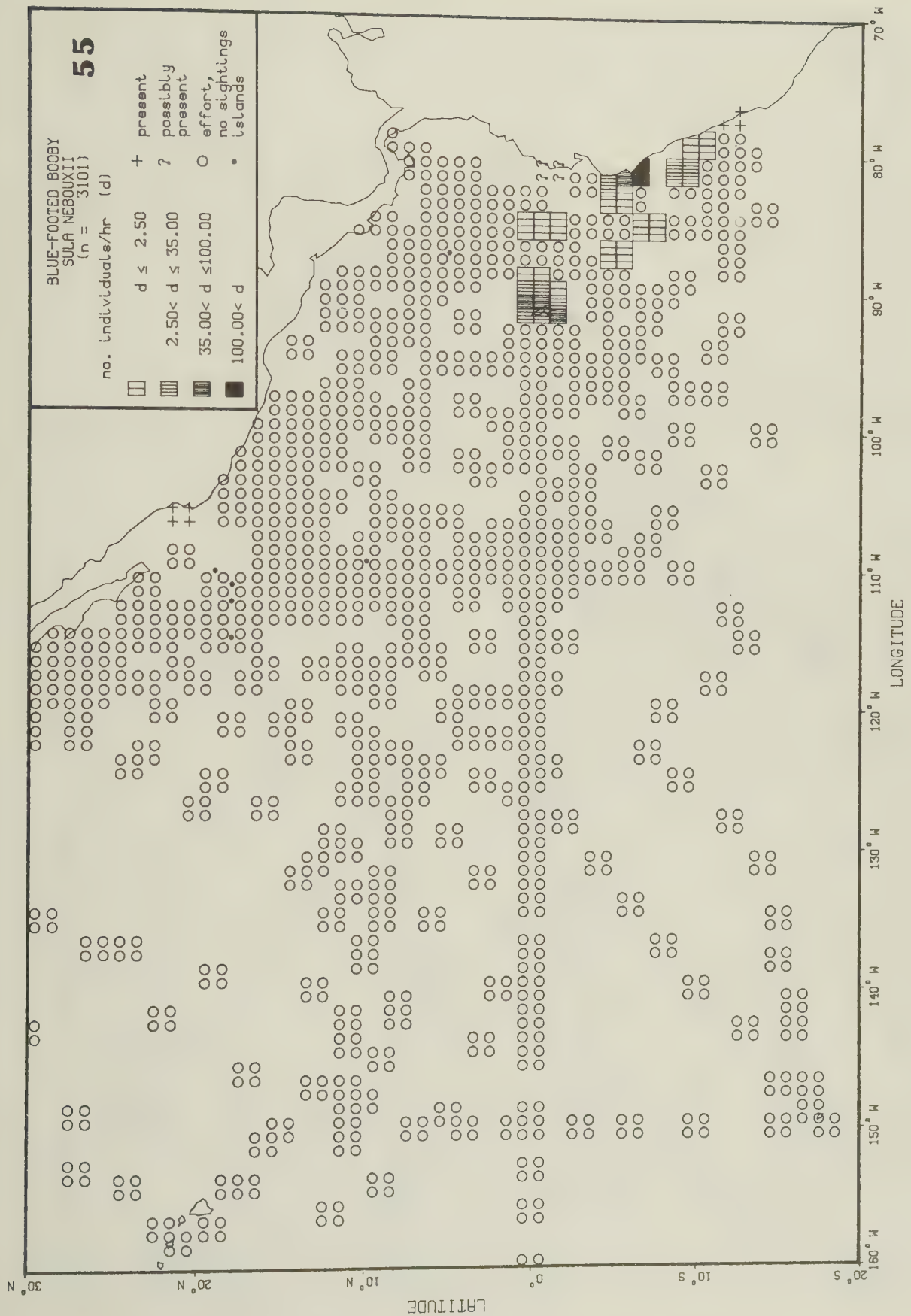


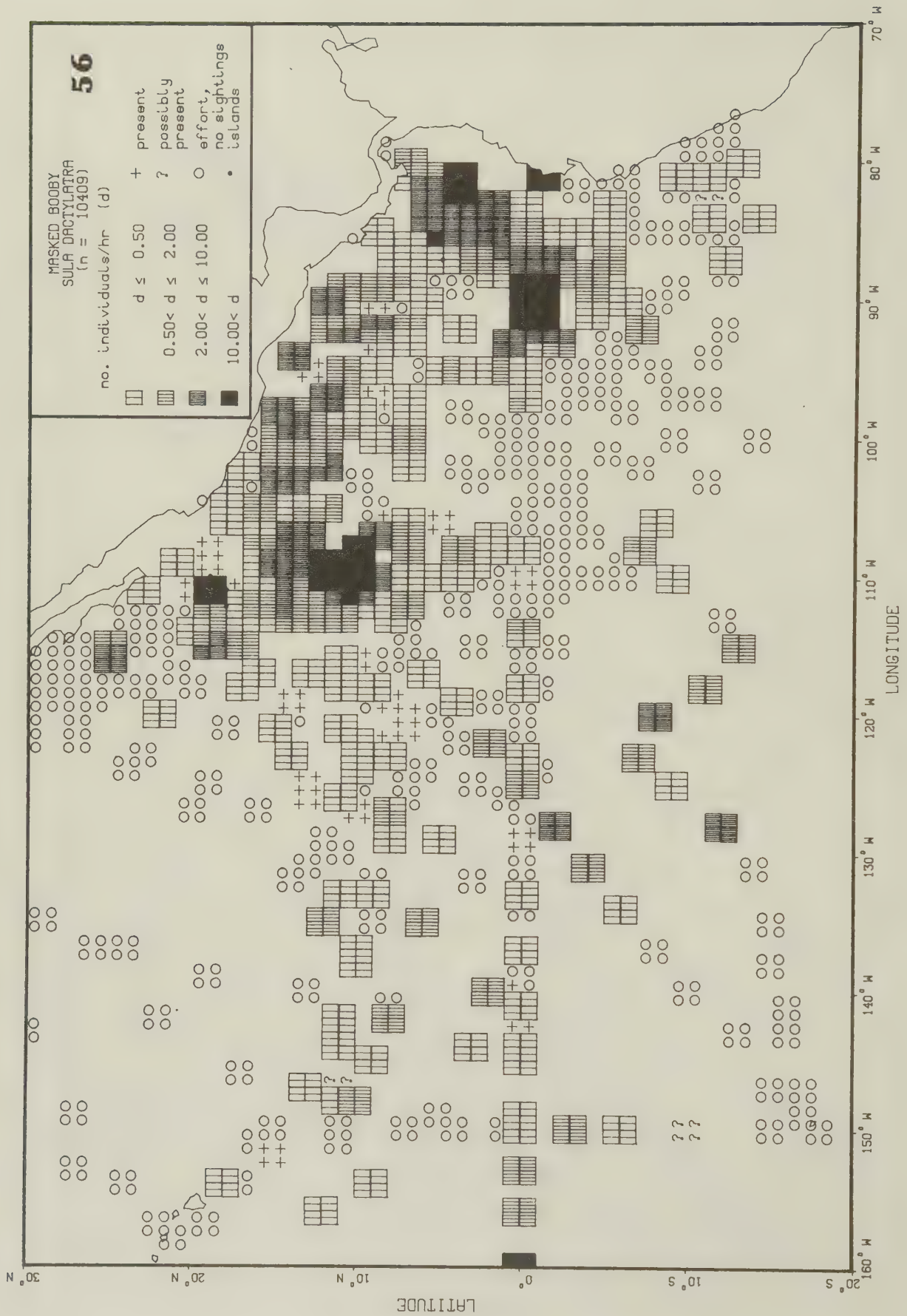


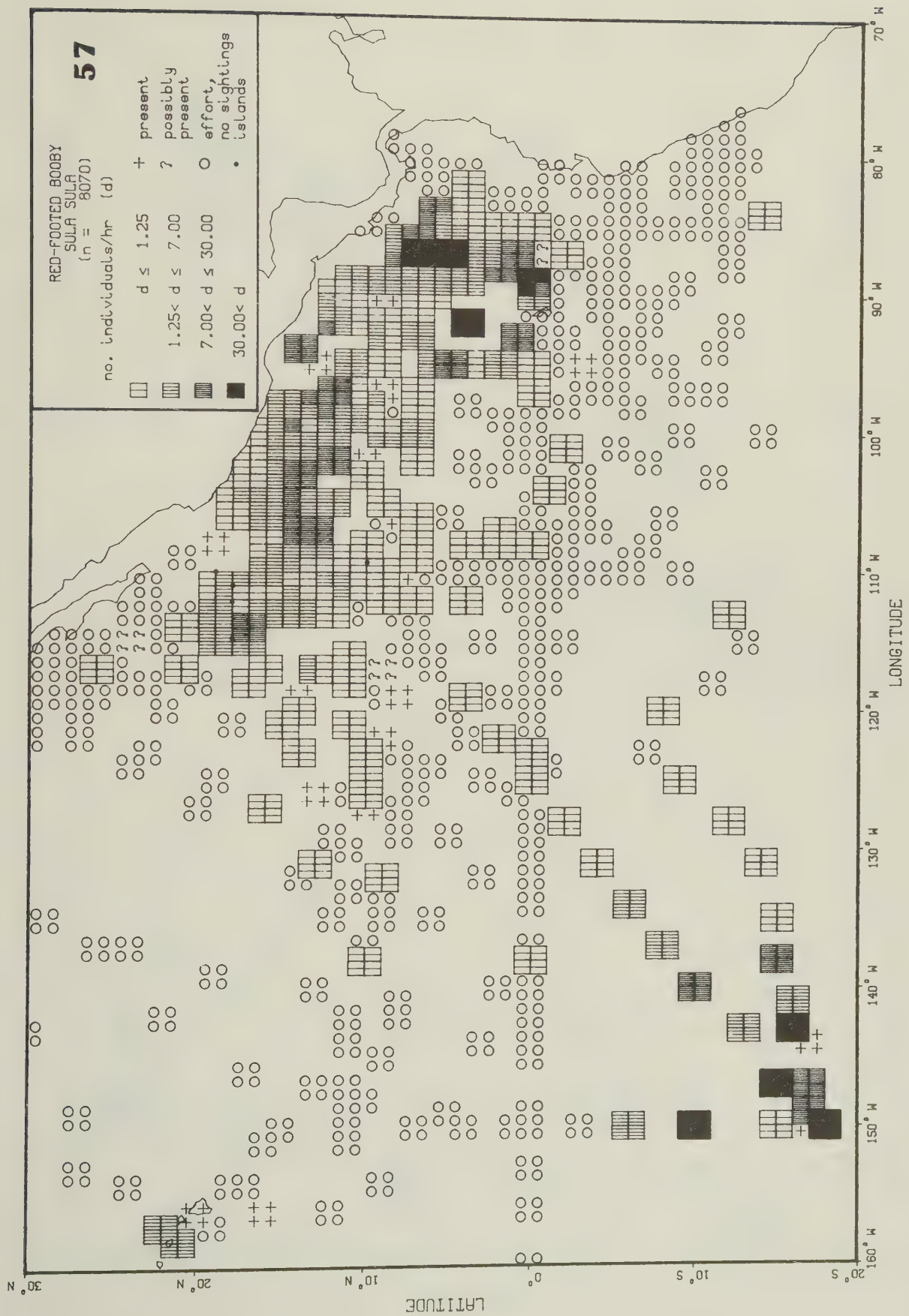


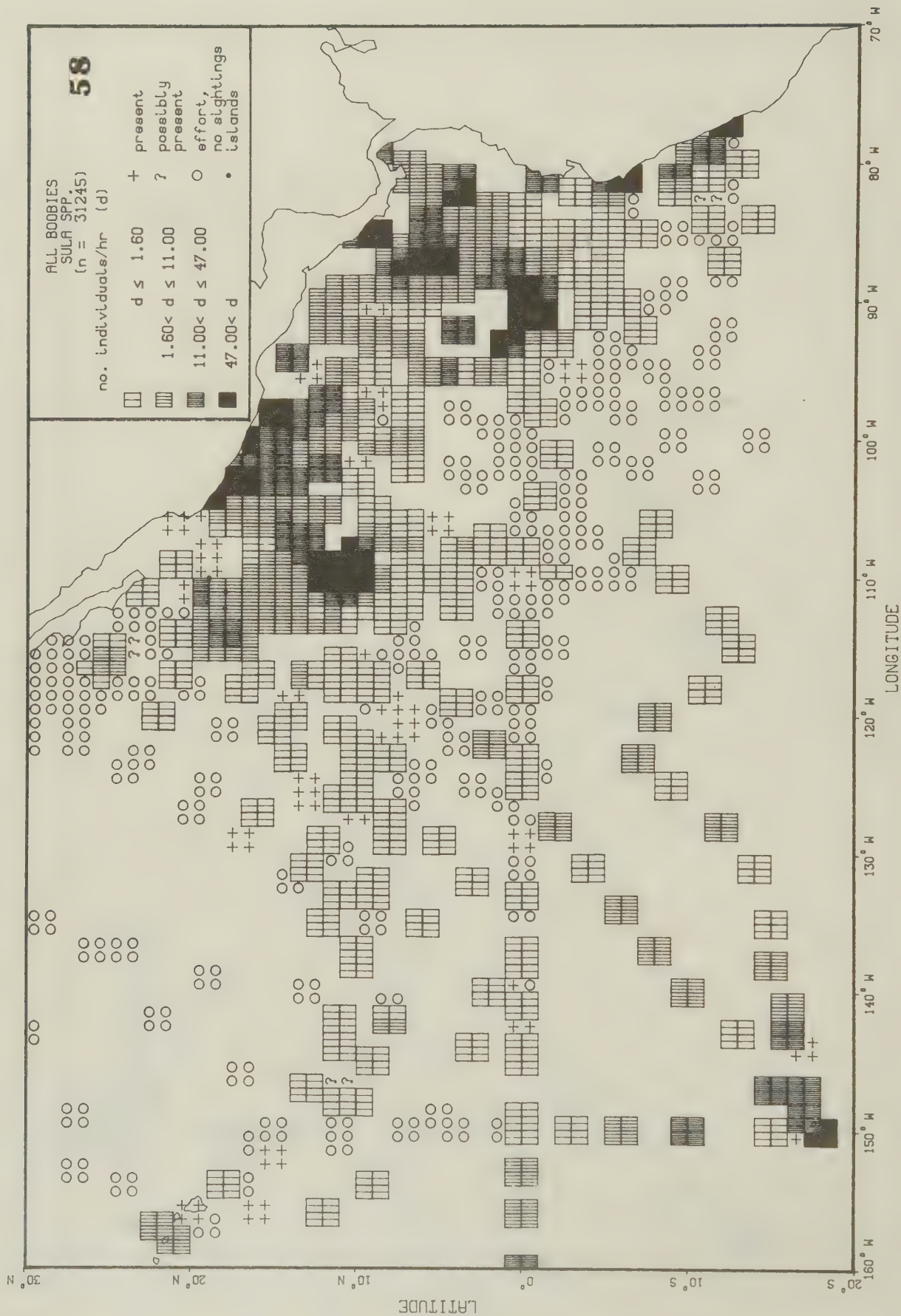


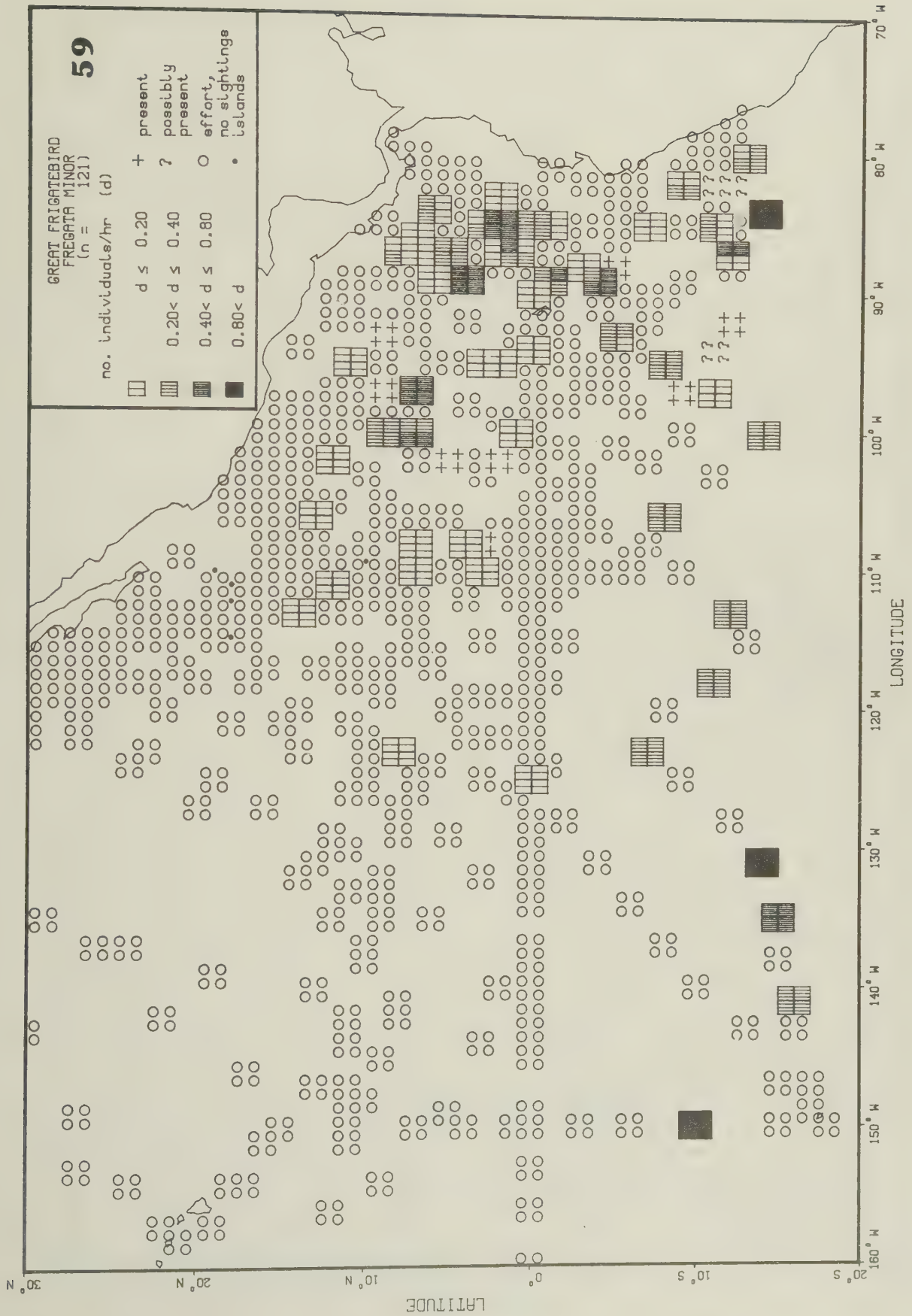


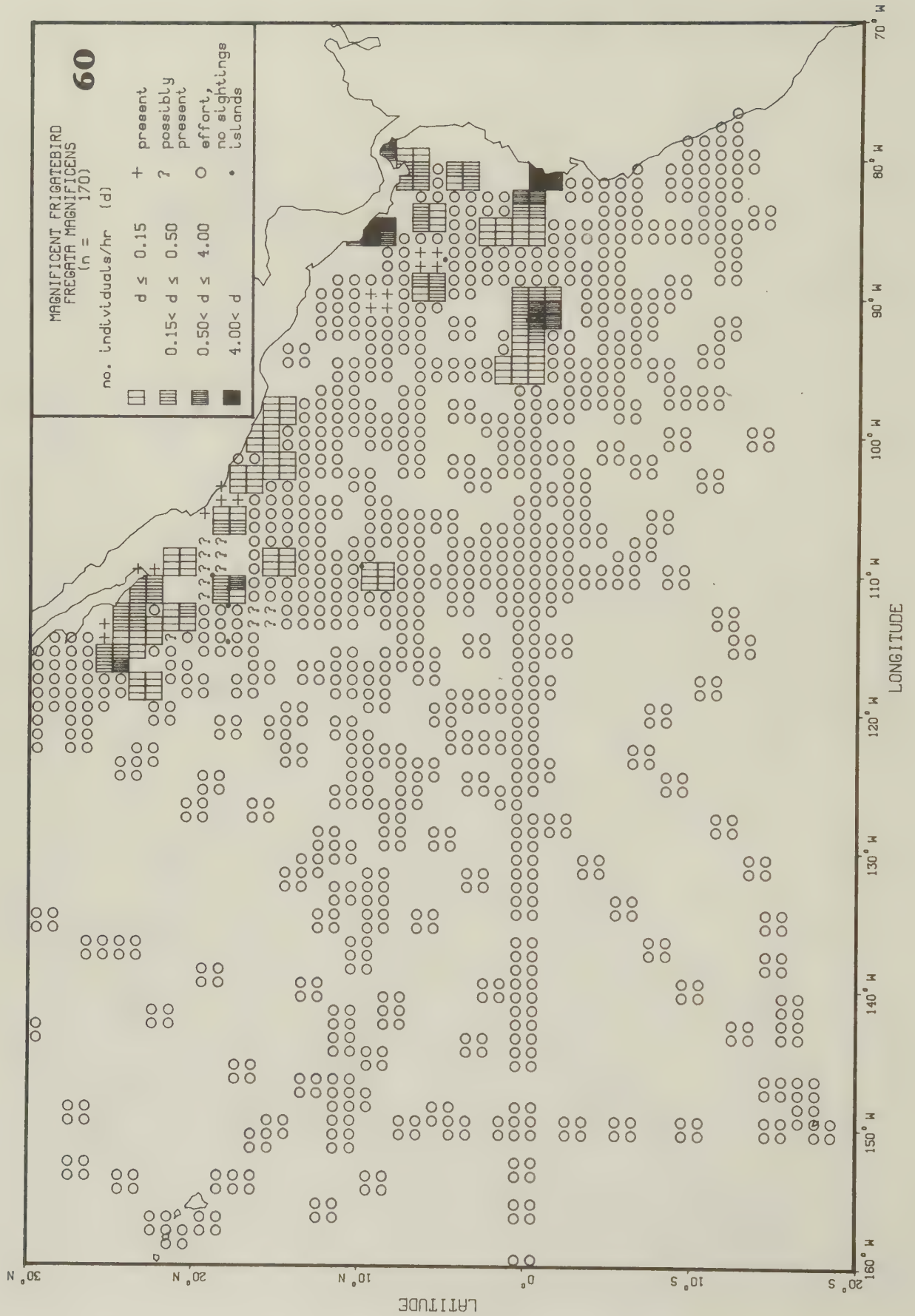


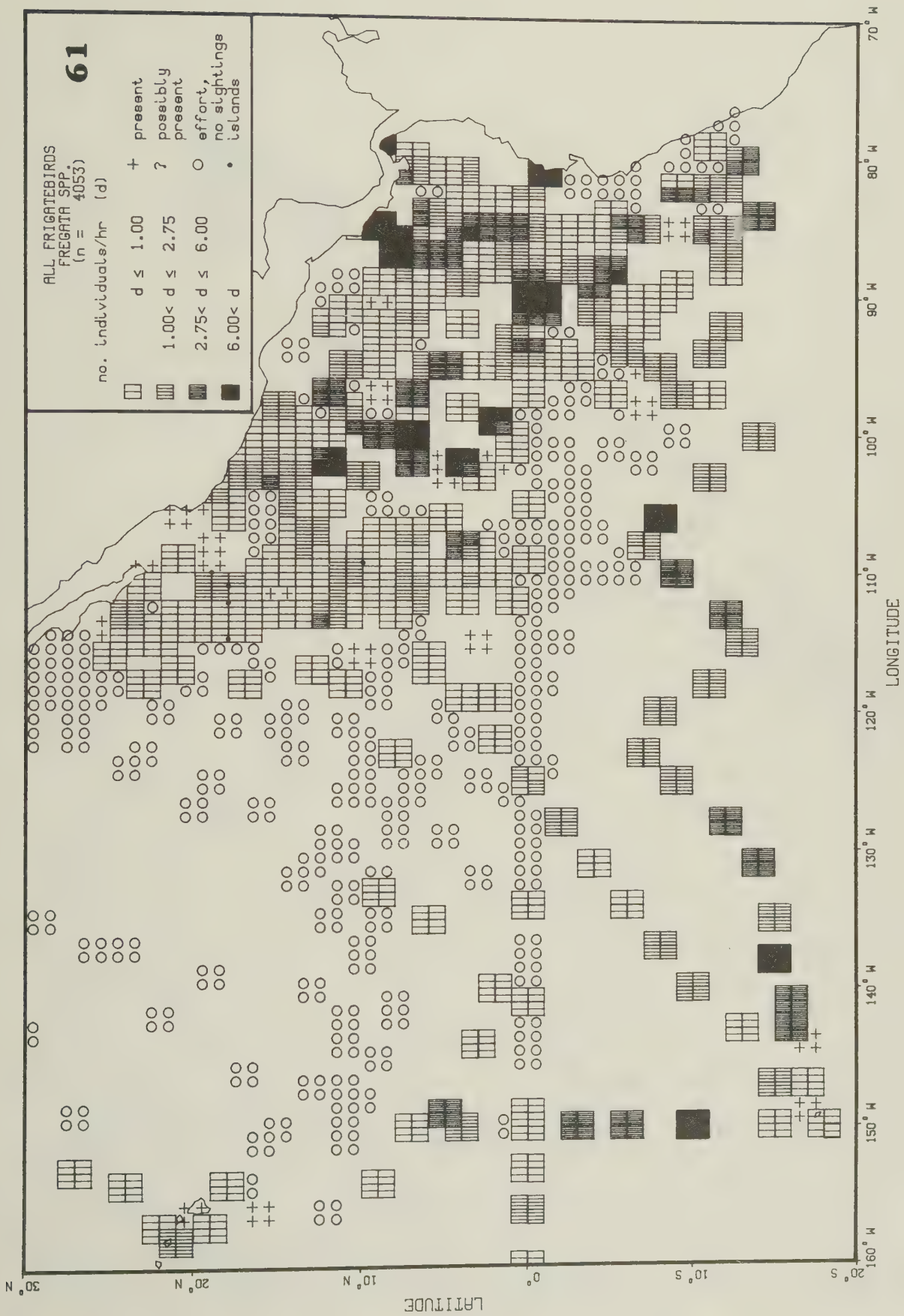


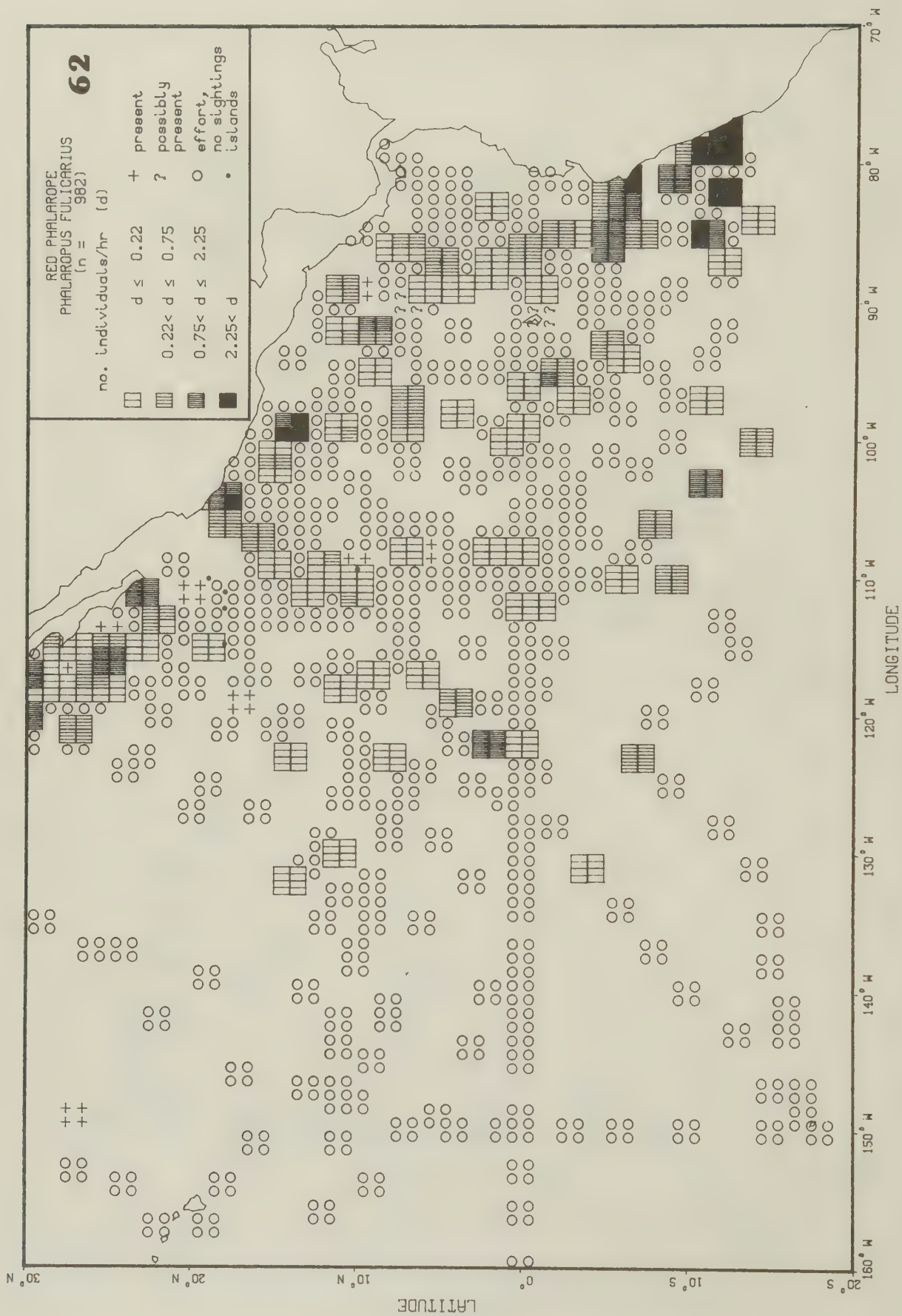


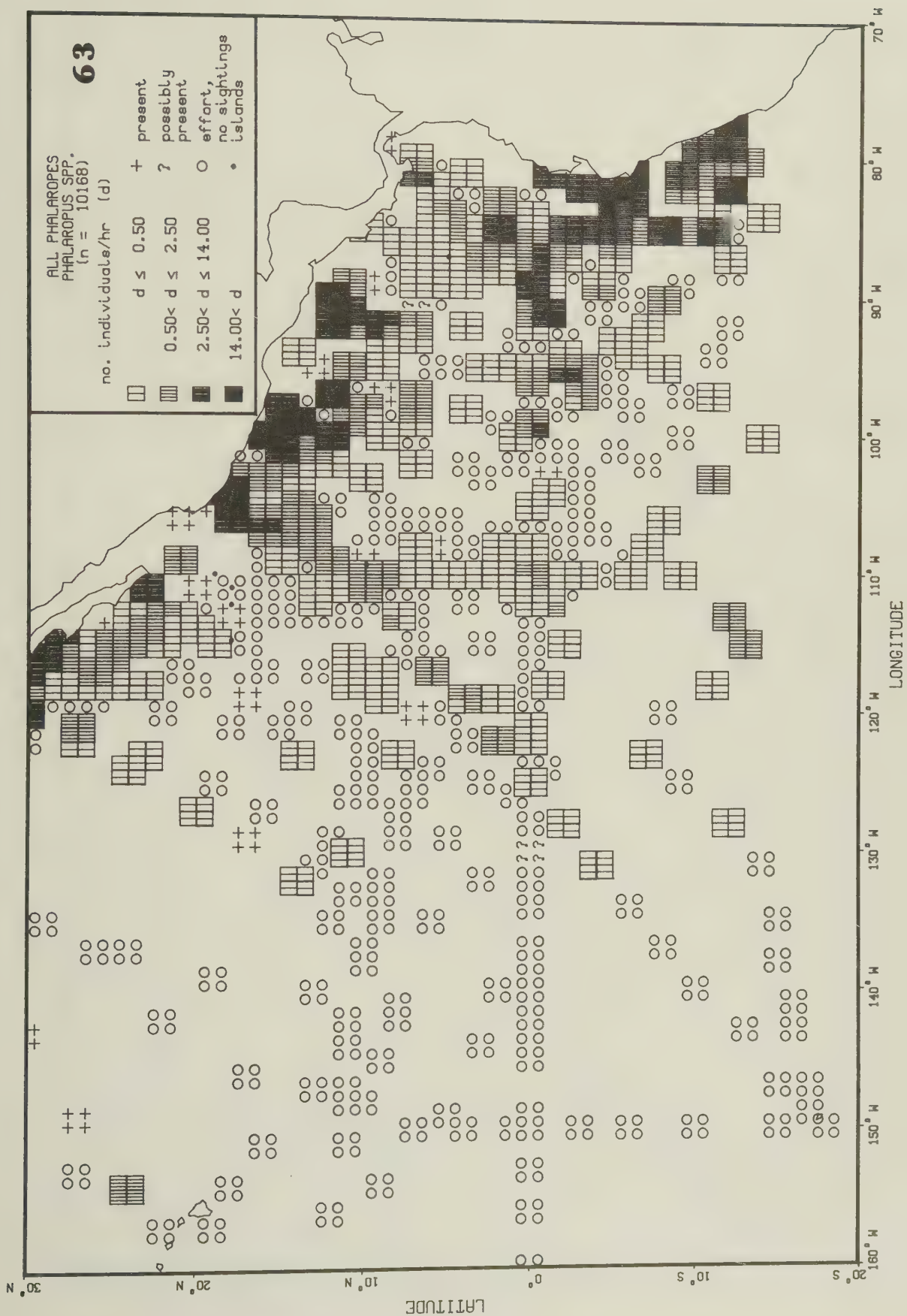


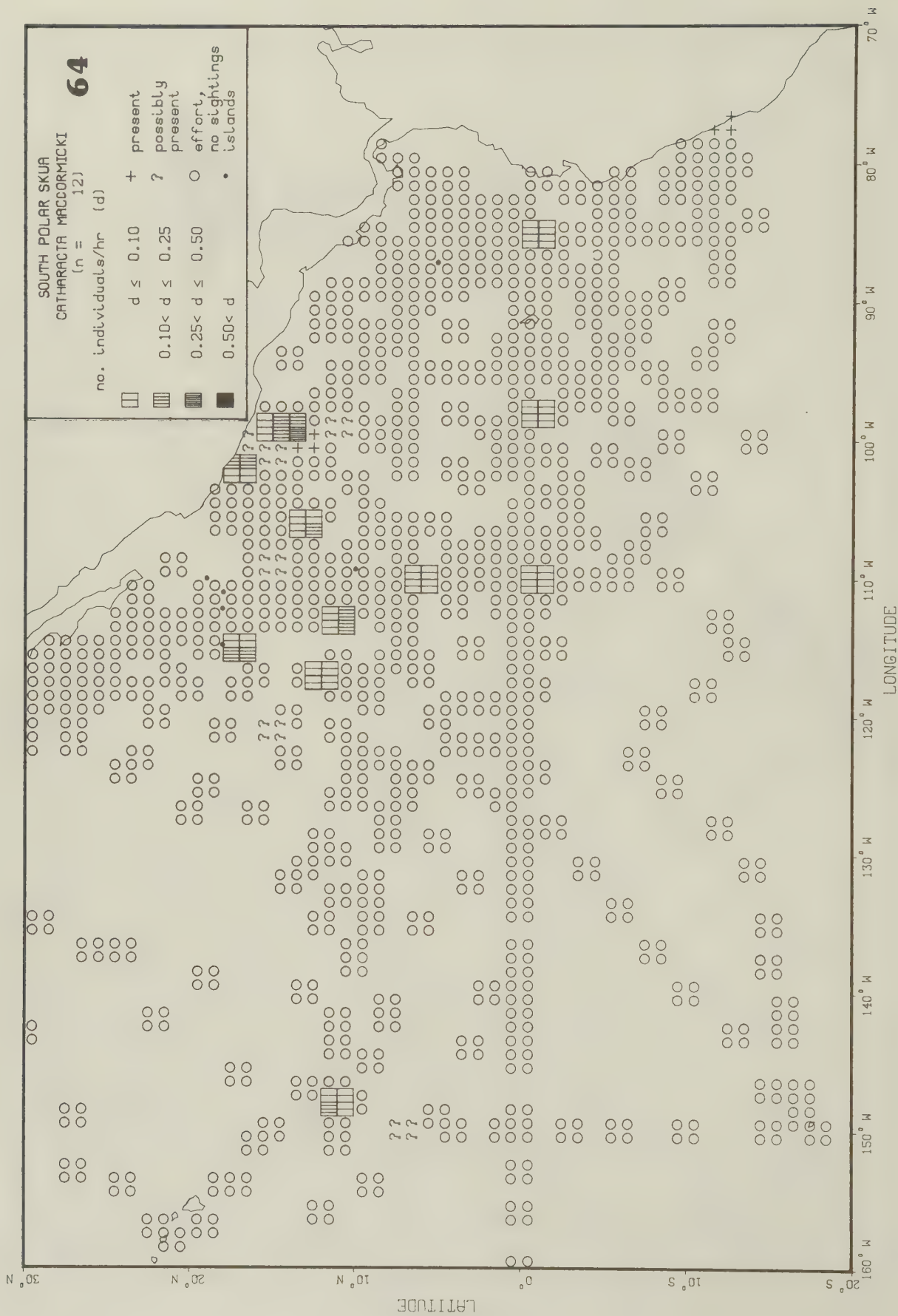


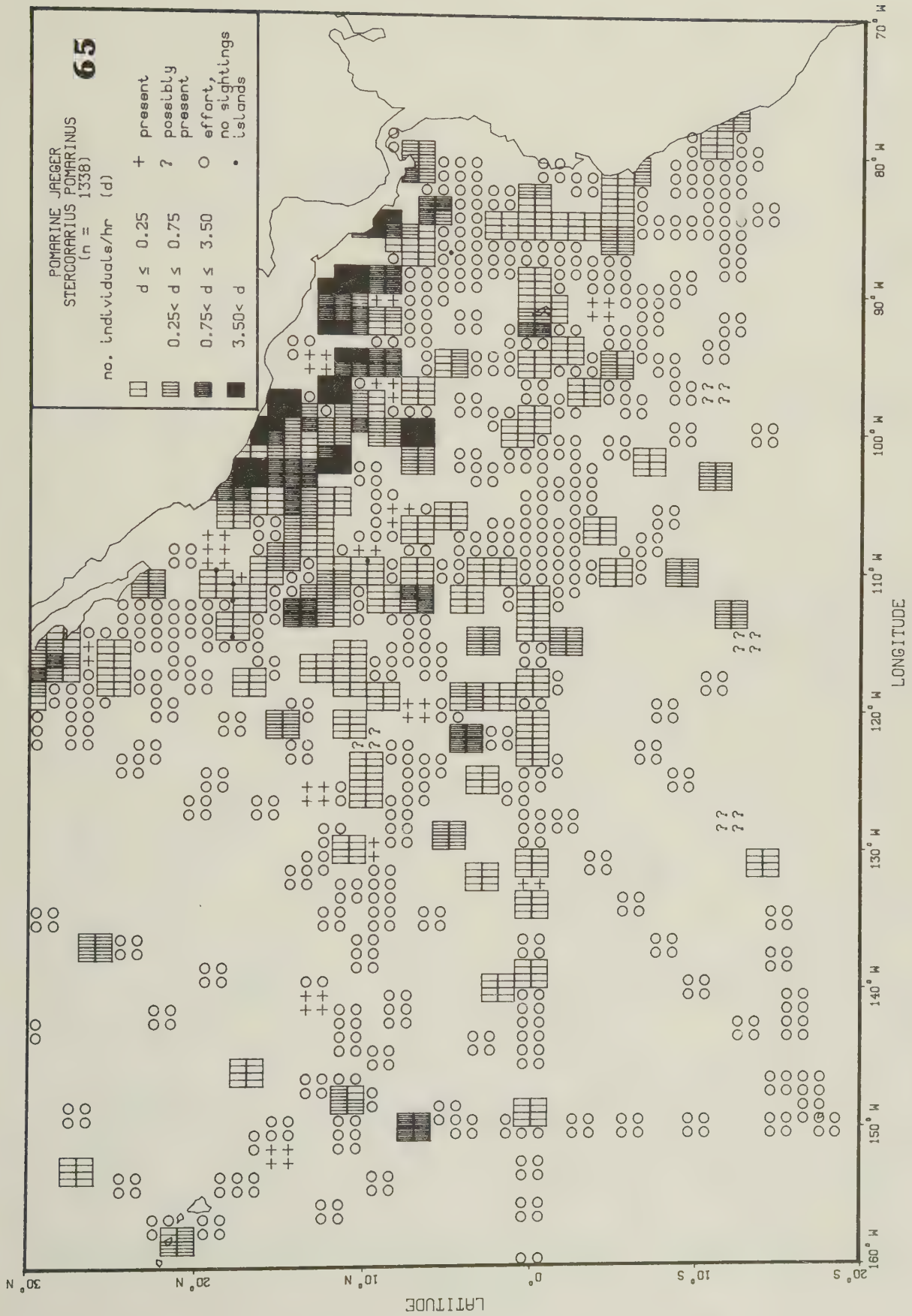


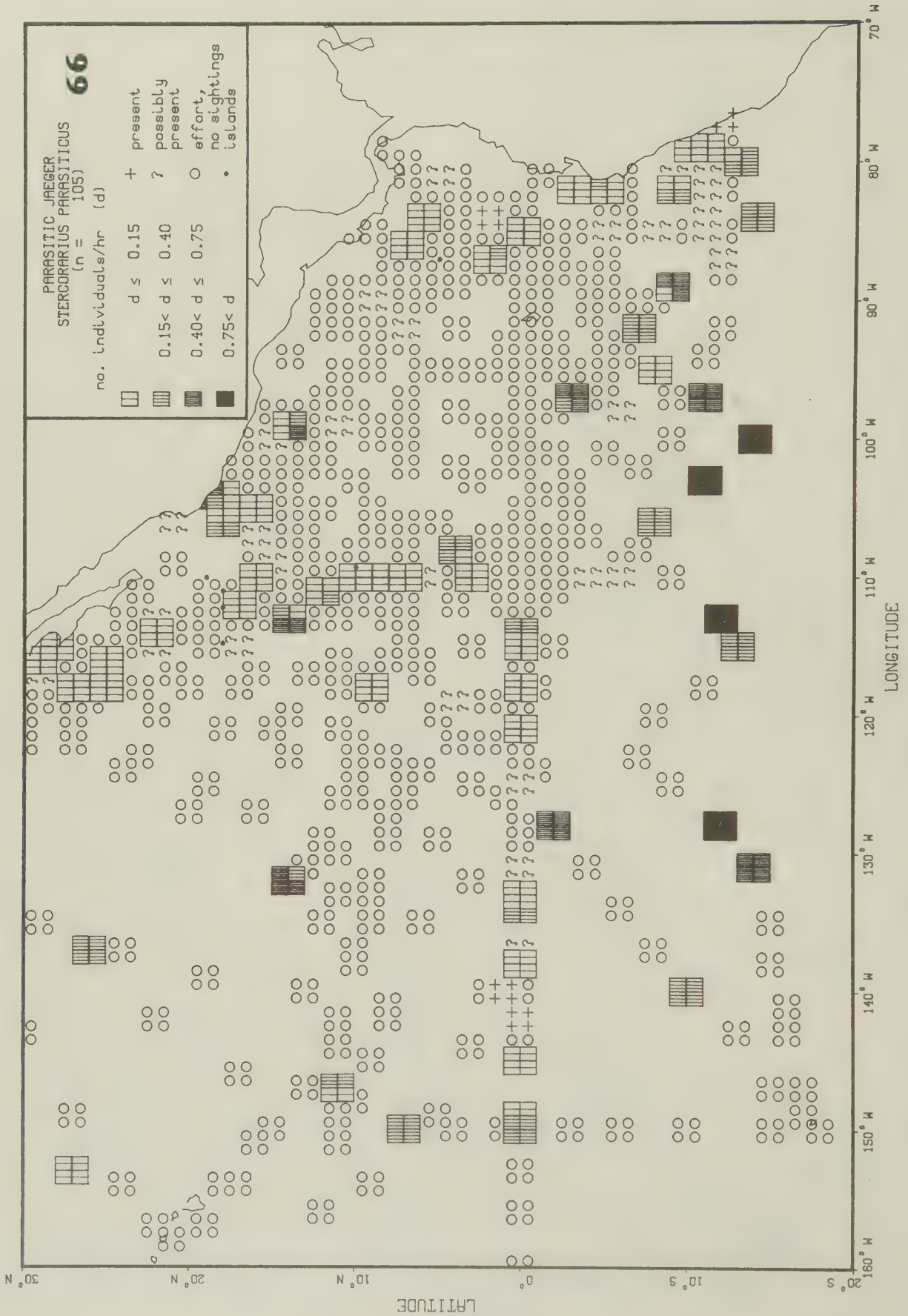


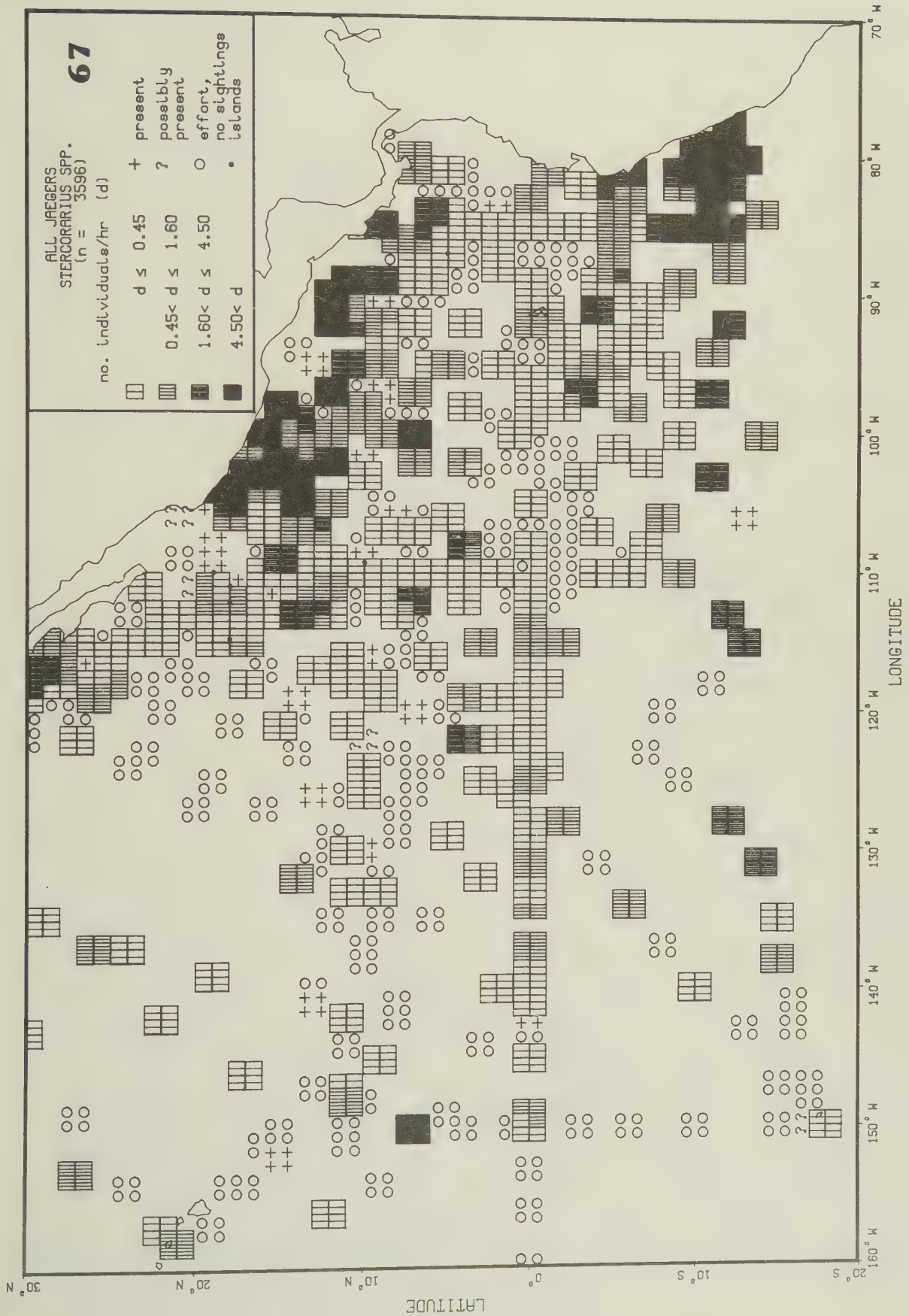


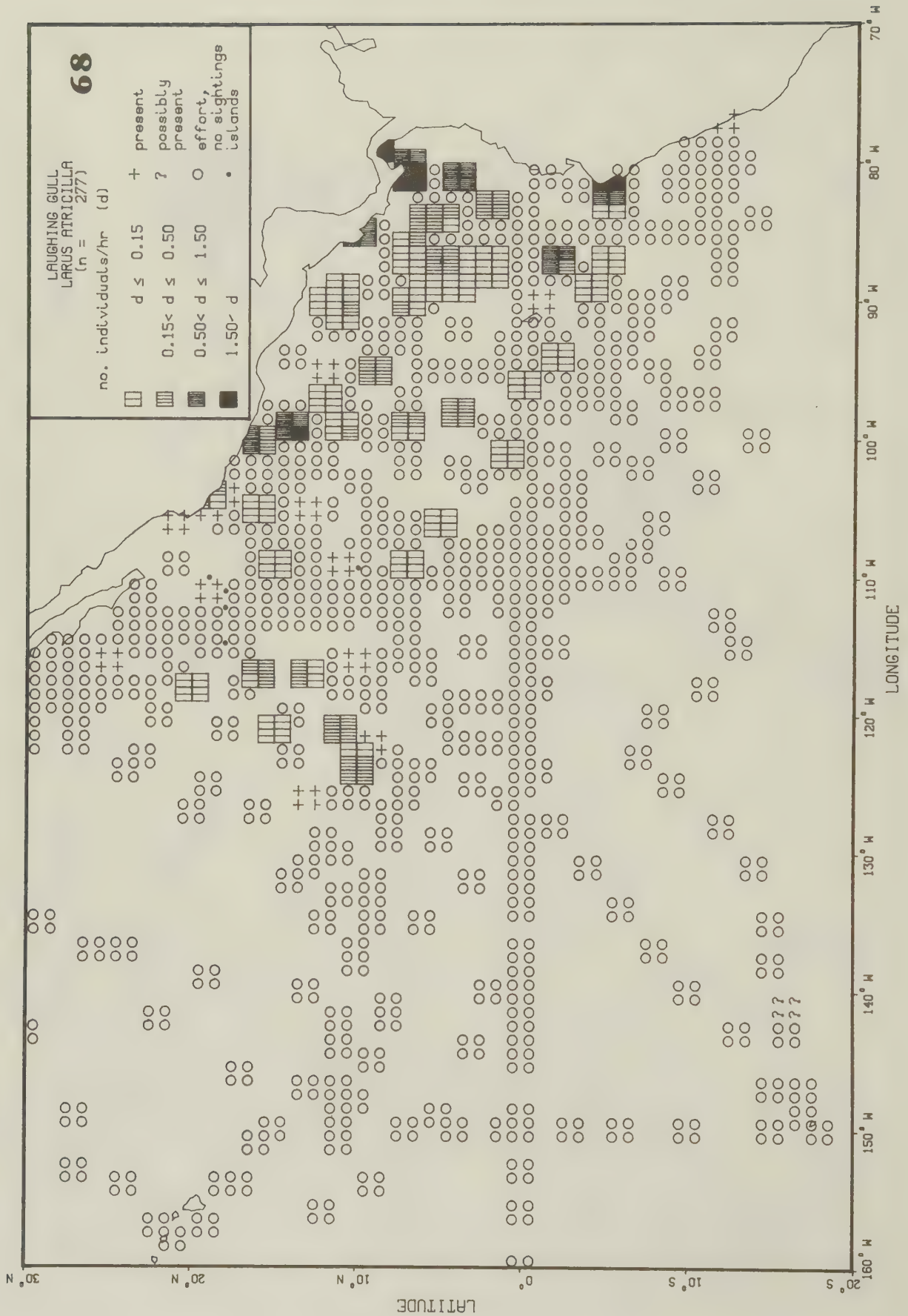


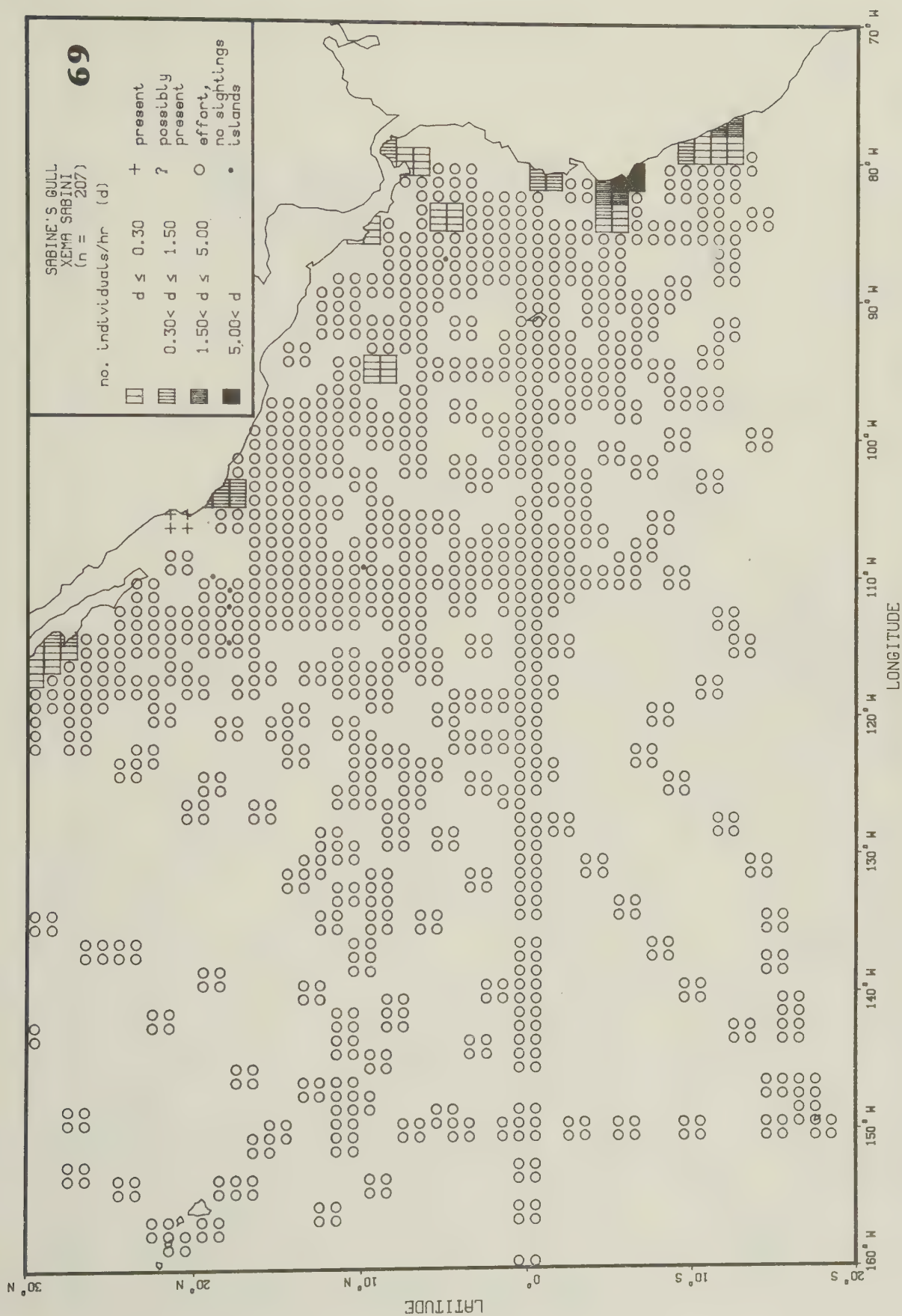


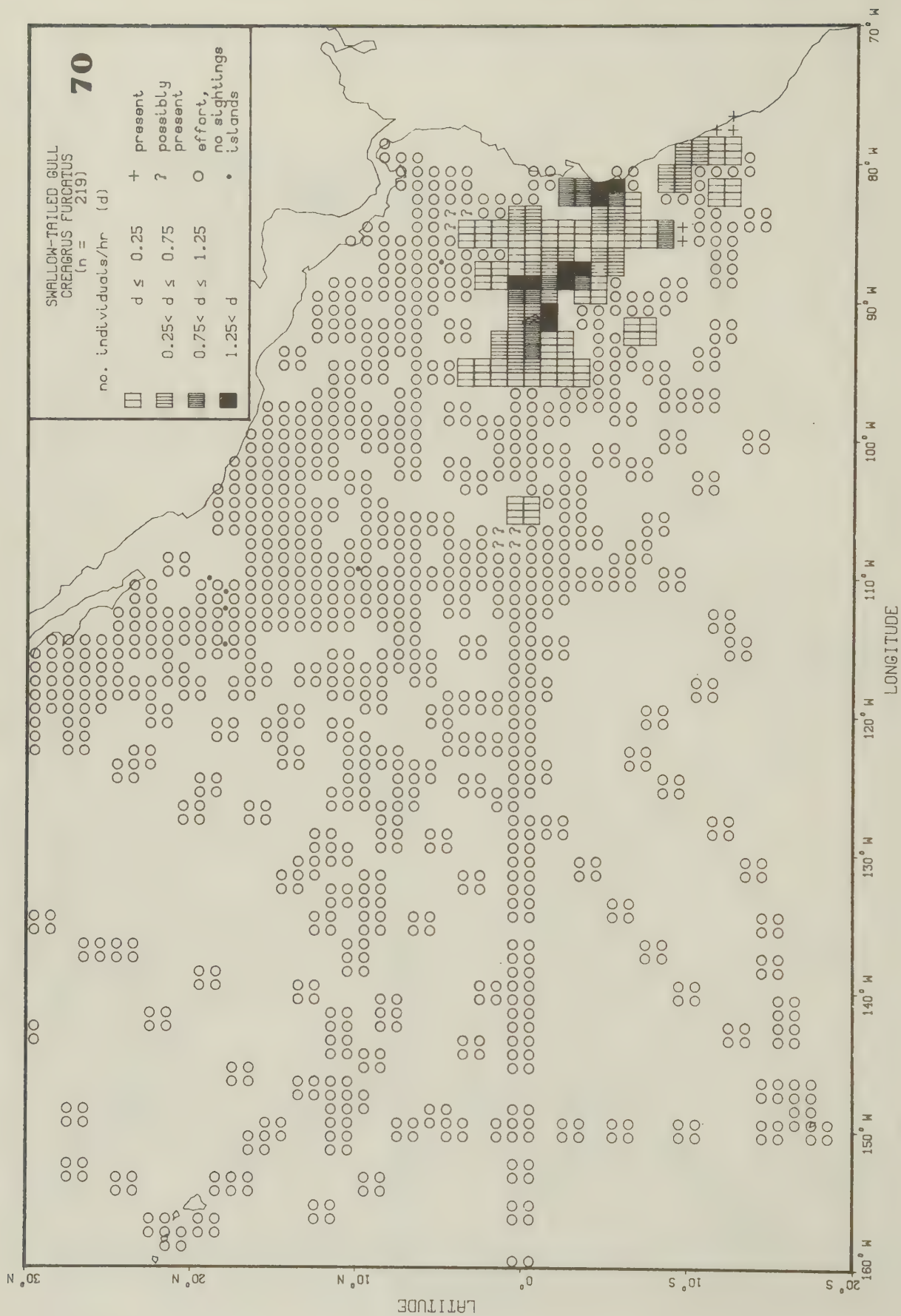


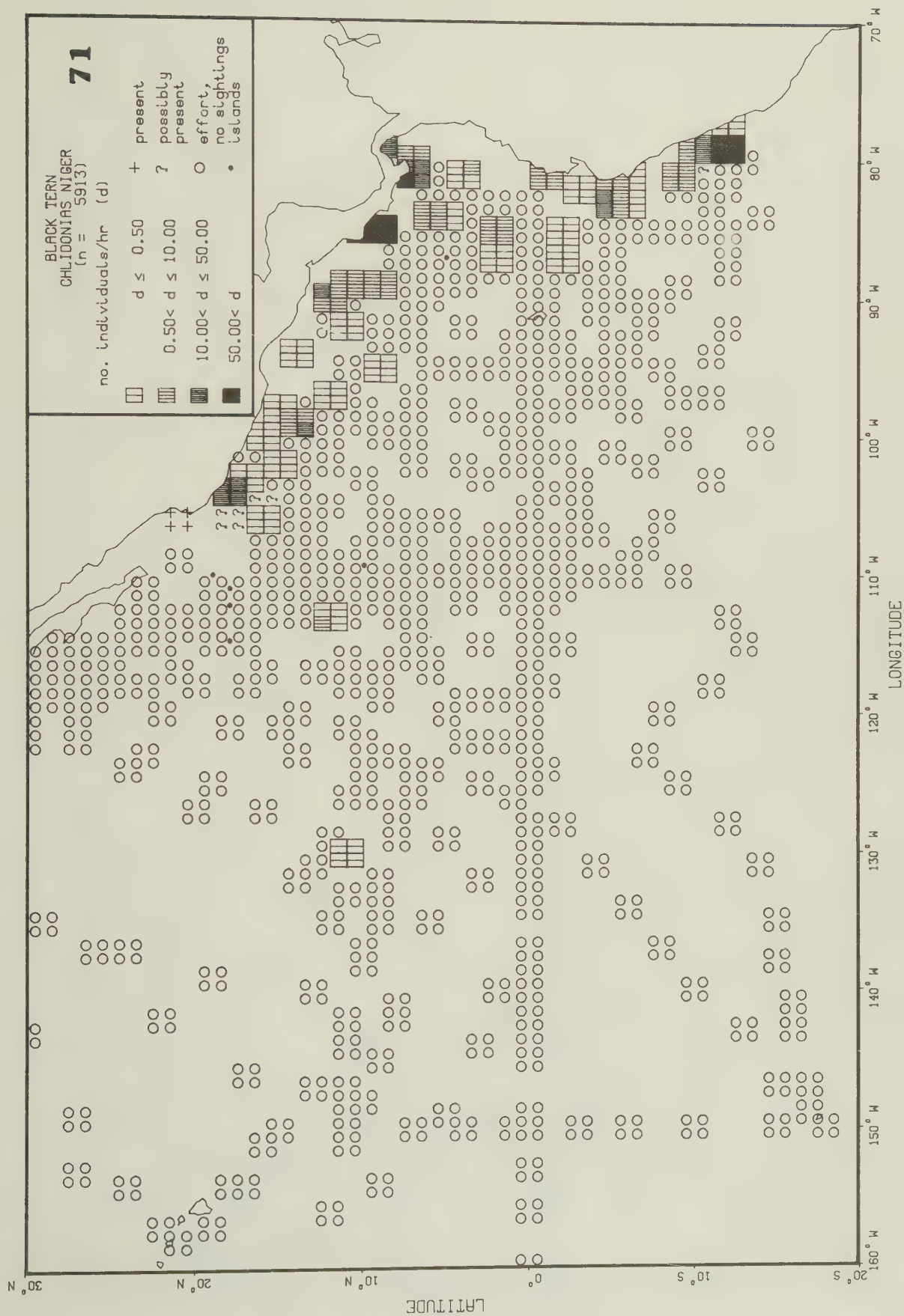


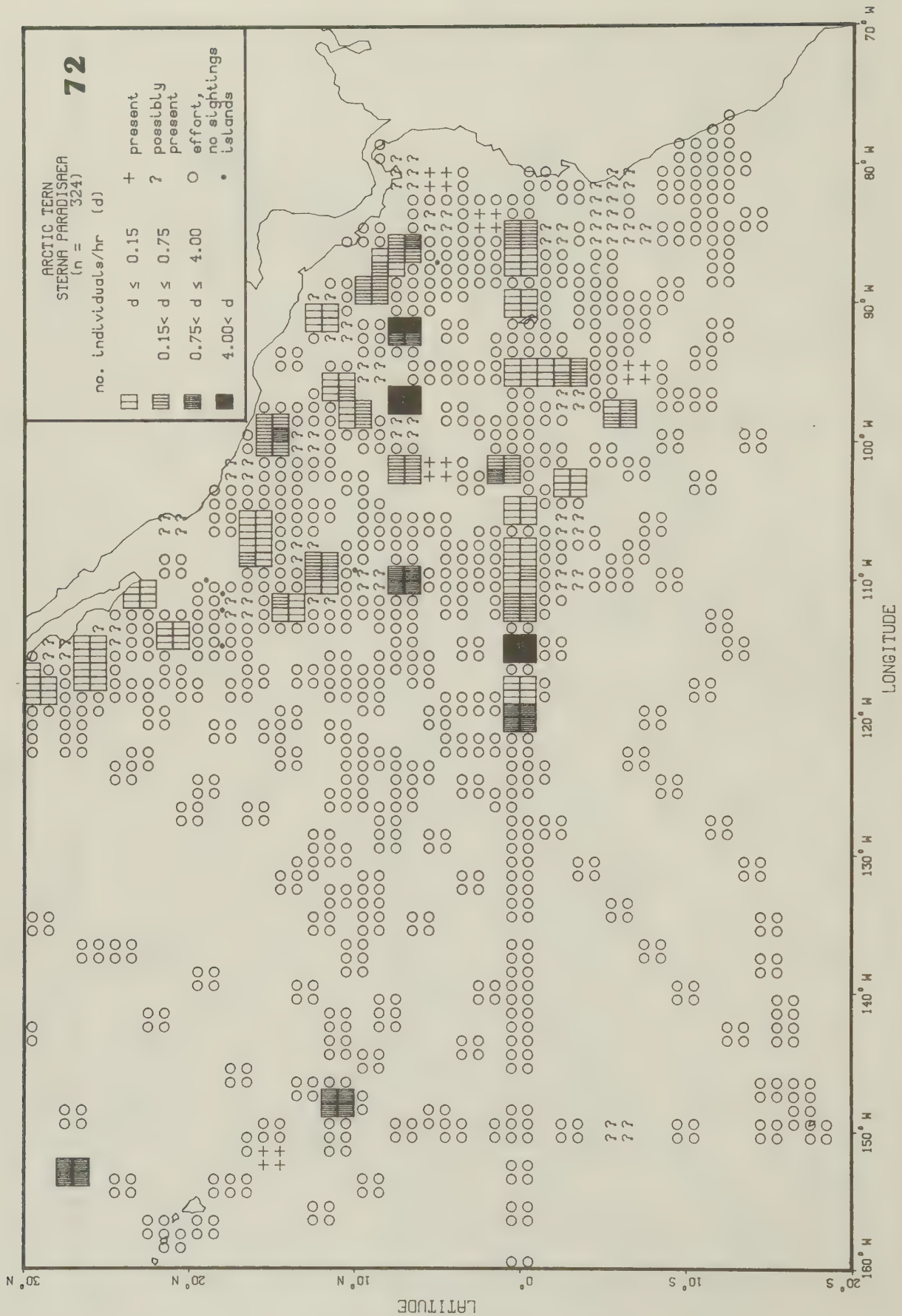


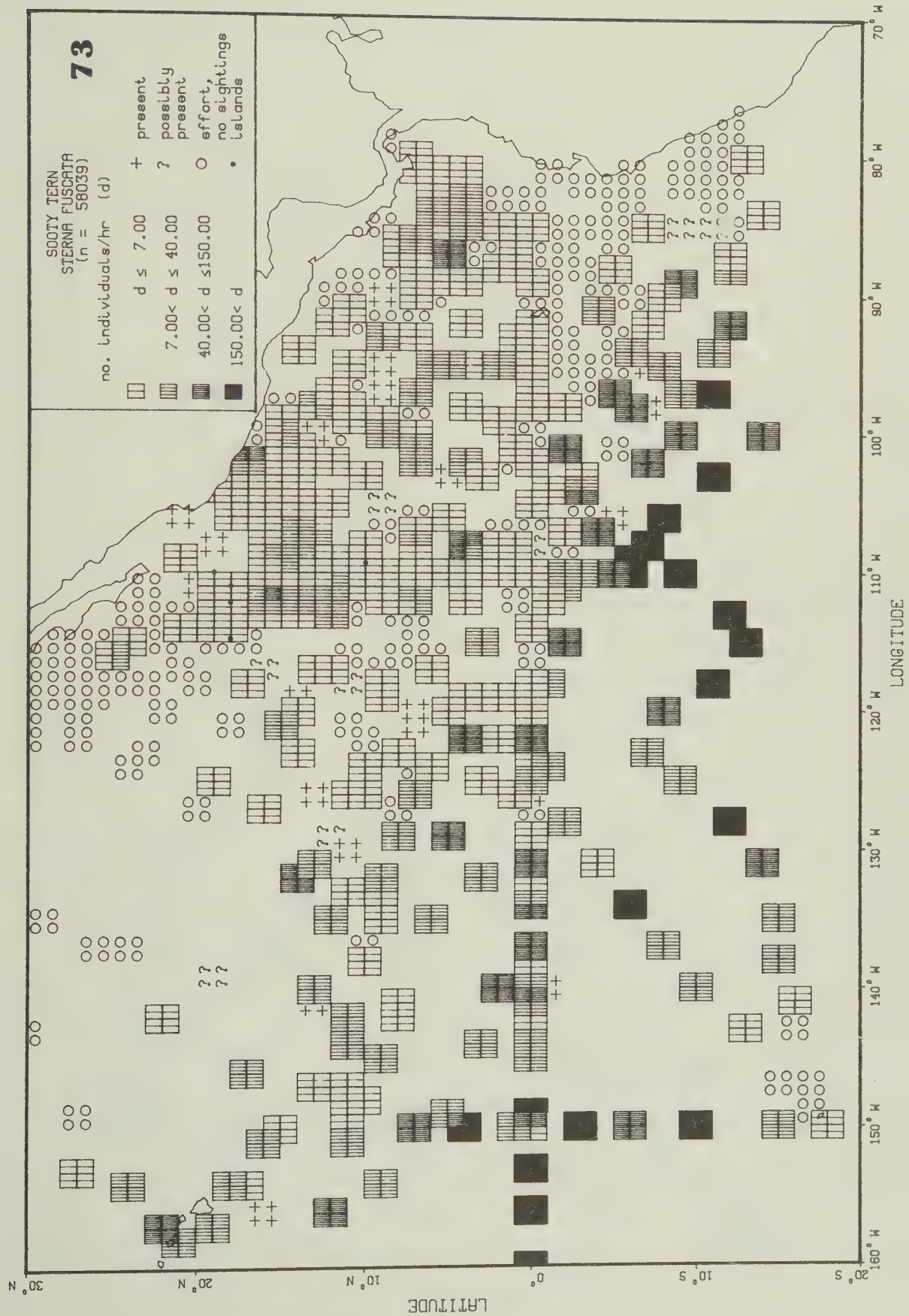


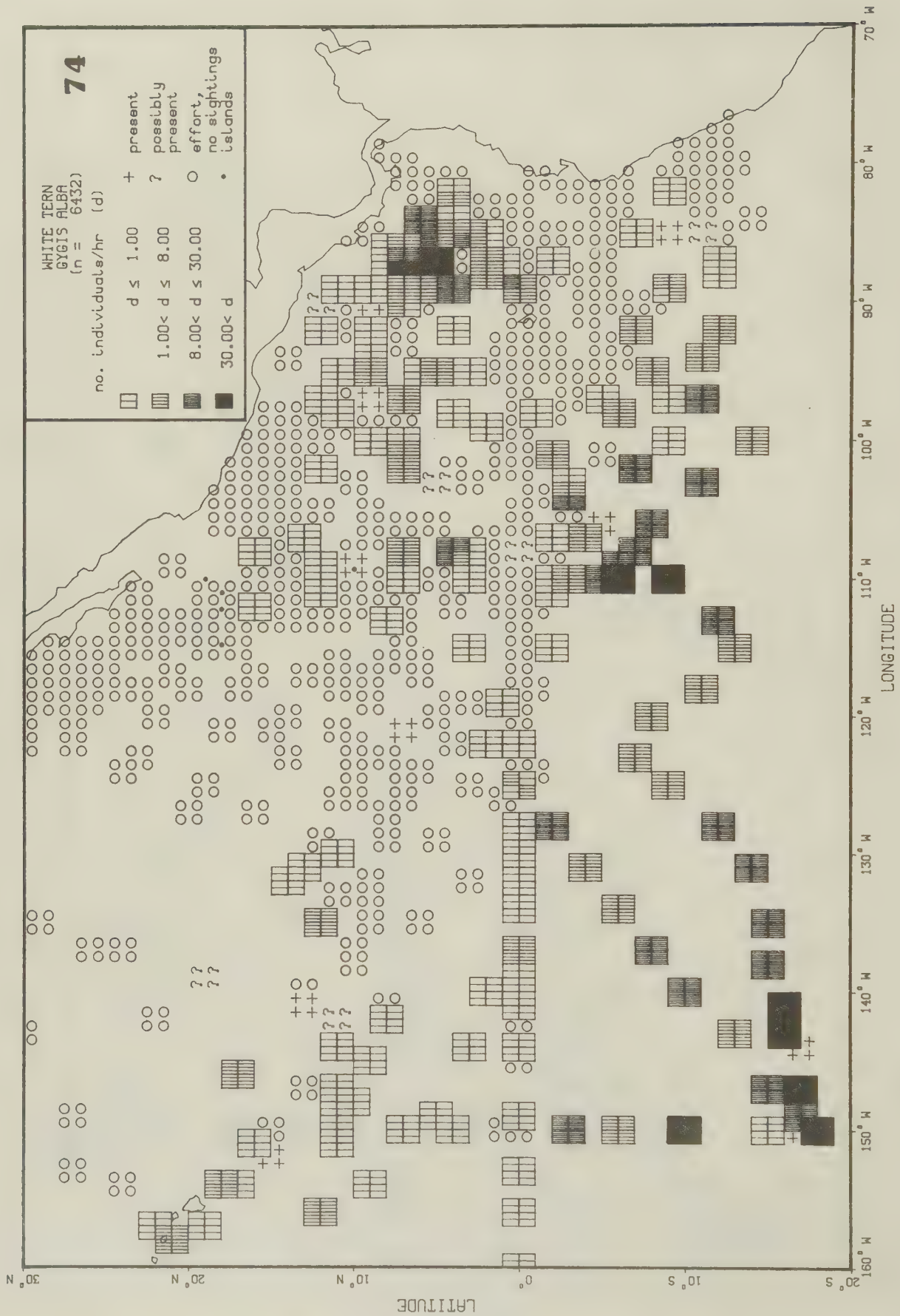


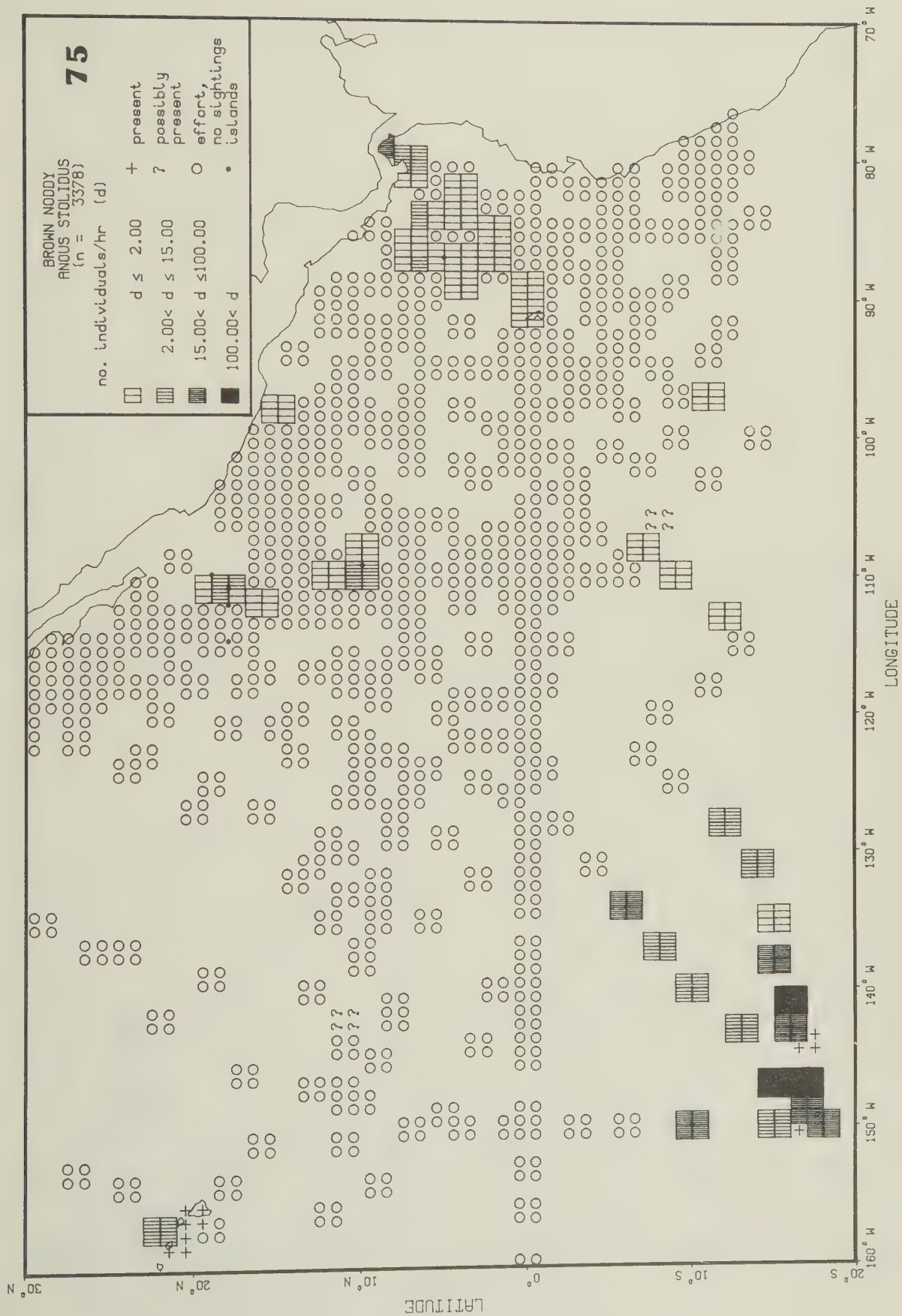


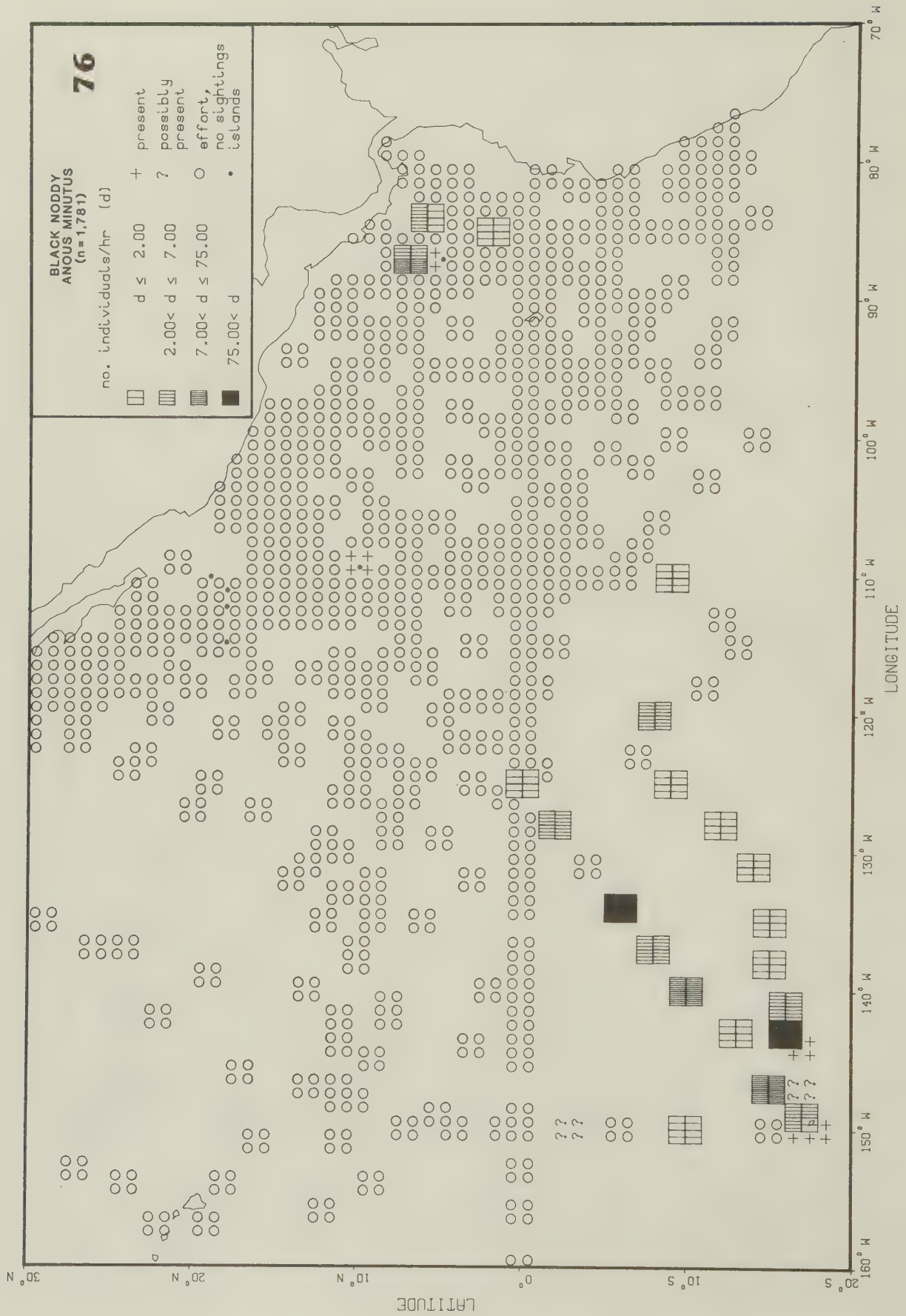


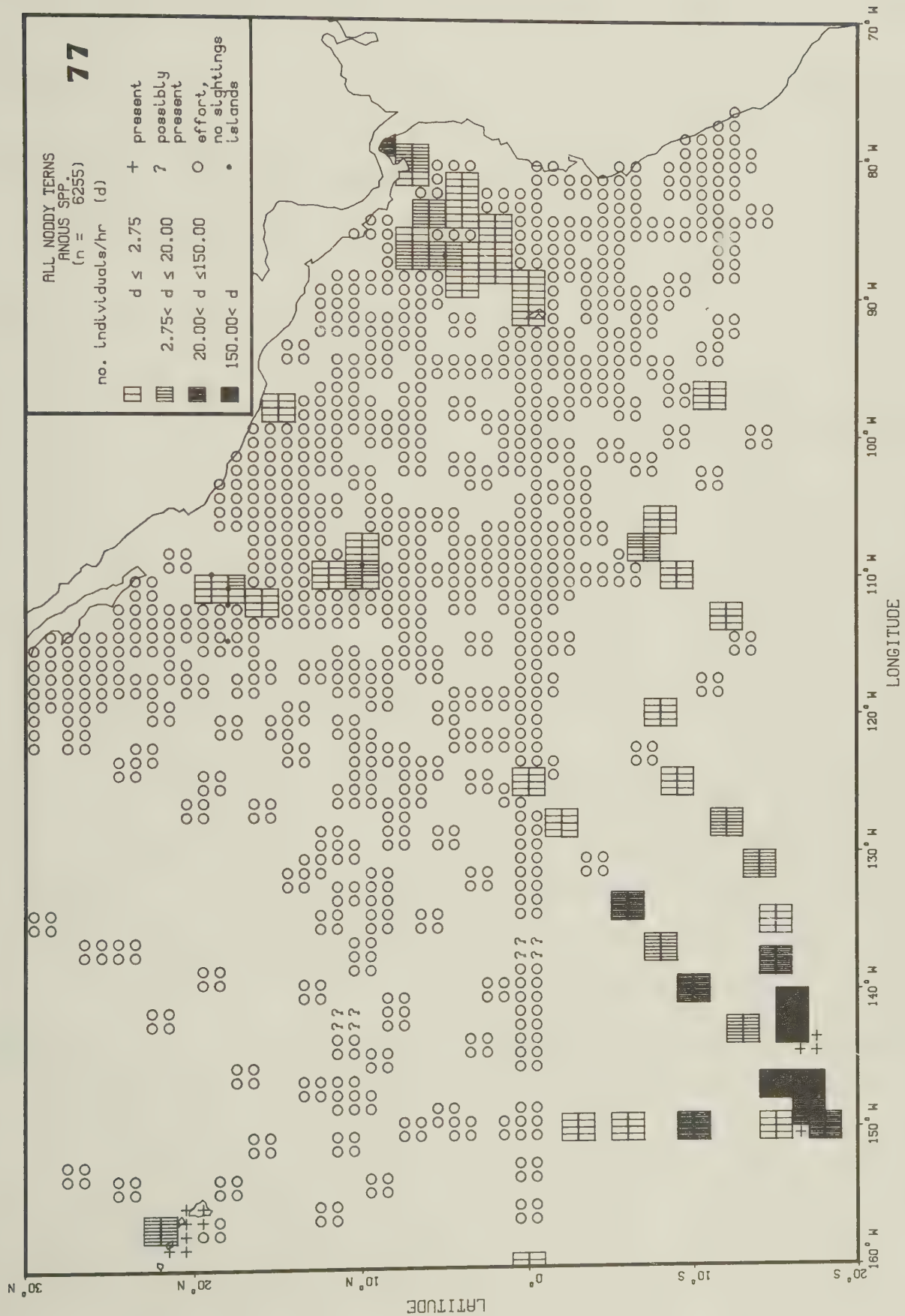












APPENDIX: INFREQUENTLY SIGHTED BIRDS IN THE EASTERN TROPICAL PACIFIC;
 + = PRESENT, ? = POSSIBLY PRESENT.

NORTHERN FULMAR (Fulmarus glacialis)

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
2	06 JAN 76	29 48 N 117 03 W	6.50	4
2	28 FEB 76	23 01 N 115 20 W	8.50	3
2	29 FEB 76	25 07 N 115 49 W	5.00	5
2	01 MAR 76	29 13 N 116 18 W	9.00	49
3	06 JAN 77	26 32 N 121 07 W	10.25	?
3	05 MAR 77	23 28 N 118 04 W	10.75	1
14	20 FEB 82	28 33 N 115 55 W	6.75	16
14	21 FEB 82	24 25 N 112 50 W	9.00	22
16	11 APR 83	27 51 N 115 17 W	5.50	1
16	29 NOV 83	22 27 N 115 07 W	6.25	1
16	30 NOV 83	27 19 N 117 36 W	6.75	4

CAPE (PINTADO) PETREL (Daption capense)

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
13	24 OCT 81	00 00 N 090 12 W	8.25	1
13	21 NOV 81	10 10 S 079 14 W	3.25	2
13	23 NOV 81	10 32 S 081 25 W	5.50	1
13	27 NOV 81	05 30 S 085 00 W	4.75	1

PHOENIX PETREL (Pterodroma alba)

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
8	10 APR 80	00 00 N 152 51 W	7.00	?
8	11 APR 80	00 00 N 156 15 W	7.75	11
18	04 MAR 84	00 35 N 149 59 W	3.50	1

MURPHY'S PETREL (Pterodroma ultima)

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
8	06 APR 80	00 00 N 137 30 W	7.25	1
12	16 JUL 81	00 01 N 138 46 W	6.25	1
12	22 JUL 81	18 31 N 138 43 W	6.75	1
14	19 APR 82	00 00 N 125 06 W	6.00	2
15	19 JUN 82	11 21 N 118 10 W	4.50	1
17	19 OCT 83	00 00 N 140 03 W	0.00	+
17	27 OCT 83	00 01 S 125 17 W	3.00	?
17	30 OCT 83	00 02 S 118 06 W	6.75	?
17	31 OCT 83	00 02 S 113 58 W	6.00	?

NEW ZEALAND SHEARWATER (Puffinus bulleri)

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
12	01 JUN 81	03 19 N 110 01 W	2.00	1
15	03 JUN 82	17 00 N 102 23 W	6.00	1
15	12 JUN 82	09 31 N 108 18 W	4.25	1
15	18 JUN 82	08 15 N 115 43 W	4.00	1
17	11 OCT 83	26 20 N 137 24 W	3.75	1

NEW ZEALAND SHEARWATER (Puffinus bulleri) - continued

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
17	15 OCT 83	05 06 N 148 47 W	6.50	1

WILSON'S STORM-PETREL (Oceanites oceanicus)

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
3	08 JAN 77	19 15 N 125 08 W	10.75	?
3	09 FEB 77	11 05 S 078 37 W	9.25	?
12	17 JUN 81	02 58 S 085 01 W	3.75	2
13	28 OCT 81	00 03 S 109 42 W	3.50	1
13	12 NOV 81	06 13 S 081 16 W	6.75	?
13	13 NOV 81	09 52 S 078 53 W	6.25	?
13	20 NOV 81	11 51 S 077 25 W	4.50	?
13	30 NOV 81	05 07 S 082 31 W	6.00	?
14	06 MAR 82	05 04 S 081 45 W	5.75	?
15	25 JUN 82	13 10 N 130 34 W	5.50	?
16	04 FEB 83	11 54 S 077 24 W	1.00	?

WHITE-BELLIED STORM-PETREL (Fregetta grallaria)

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
3	29 JAN 77	10 58 S 094 12 W	11.50	4
3	30 JAN 77	11 47 S 091 32 W	10.25	9
3	31 JAN 77	11 46 S 088 21 W	11.25	6
10	07 AUG 80	00 00 N 107 07 W	4.25	?
10	08 AUG 80	00 00 N 109 51 W	2.50	?

WHITE-BELLIED STORM-PETREL (Fregetta grallaria) - continued

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
16	10 FEB 83	12 11 S 086 34 W	4.50	1

BROWN PELICAN (Pelecanus occidentalis)

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
1	28 NOV 74	19 09 N 104 45 W	3.00	+
2	06 JAN 76	29 48 N 117 03 W	6.50	2
2	30 JAN 76	00 54 S 089 36 W	0.00	50
2	04 FEB 76	09 39 N 084 47 W	3.50	+
3	04 FEB 77	11 56 S 077 19 W	0.00	?
4	08 APR 78	20 33 N 105 45 W	4.50	75
4	18 APR 78	22 53 N 109 54 W	0.00	+
5	27 FEB 79	19 04 N 104 19 W	0.00	+
6	17 OCT 79	27 37 N 115 11 W	7.50	1
7	28 JAN 80	08 38 N 079 27 W	1.50	106
7	01 FEB 80	06 51 N 080 40 W	8.75	2
7	07 FEB 80	08 39 N 092 15 W	7.25	1
9	07 JUL 80	27 58 N 115 07 W	9.00	+
10	28 JUL 80	08 43 N 079 30 W	1.00	+
10	01 AUG 80	00 54 S 089 53 W	2.75	+
12	23 JUN 81	08 57 N 079 34 W	0.00	+
12	28 JUN 81	08 42 N 079 27 W	2.25	+
12	02 JUL 81	00 26 S 090 18 W	4.50	+
13	14 NOV 81	11 59 S 077 17 W	0.75	+

BROWN PELICAN (Pelecanus occidentalis) - continued

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
13	29 NOV 81	05 09 S 081 36 W	2.25	16
14	20 FEB 82	28 33 N 115 55 W	6.75	2
15	04 JUN 82	18 50 N 104 11 W	1.00	+
15	02 AUG 82	29 48 N 115 54 W	0.75	+
16	15 JAN 83	21 25 N 113 26 W	3.00	1
16	11 APR 83	27 51 N 115 17 W	5.50	6
17	10 NOV 83	18 18 N 104 00 W	3.00	+

LESSER FRIGATEBIRD (Fregata ariel)

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
16	22 FEB 83	10 34 S 117 58 W	4.50	1
16	26 FEB 83	11 38 S 127 51 W	4.75	2
16	01 MAR 83	14 50 S 138 30 W	3.00	4
16	02 MAR 83	15 51 S 140 52 W	3.75	2
16	03 MAR 83	16 07 S 142 31 W	3.75	2
16	14 MAR 83	14 56 S 146 45 W	3.50	1
16	17 MAR 83	08 30 S 136 51 W	6.00	1

NORTHERN PHALAROPE (Phalaropus lobatus)

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
2	31 JAN 76	00 11 N 089 06 W	10.00	230
4	08 APR 78	20 33 N 105 45 W	4.50	7
6	18 OCT 79	29 52 N 116 39 W	9.75	1

NORTHERN PHALAROPE (Phalaropus lobatus) - continued

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
7	13 FEB 80	19 04 N 104 20 W	2.50	300
9	07 JUL 80	27 58 N 115 07 W	9.00	20
10	26 AUG 80	18 58 N 104 29 W	2.25	6
14	06 APR 82	01 10 S 091 03 W	7.75	?
16	20 JAN 83	14 24 N 099 06 W	3.50	750
16	03 FEB 83	10 32 S 079 30 W	3.50	?
17	10 NOV 83	18 18 N 104 00 W	3.00	?

LONG-TAILED JAEGER (Stercorarius longicaudus)

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
2	14 FEB 76	04 55 S 085 50 W	12.00	?
3	01 FEB 77	11 46 S 085 10 W	11.50	1
3	02 FEB 77	11 52 S 081 53 W	11.75	?
3	10 FEB 77	08 54 S 080 48 W	11.25	4
3	13 FEB 77	05 17 S 088 12 W	11.50	?
3	14 FEB 77	04 18 S 090 54 W	10.75	?
4	08 APR 78	20 33 N 105 45 W	4.50	?
14	12 APR 82	06 26 S 097 31 W	6.50	?
14	17 APR 82	00 01 N 114 41 W	6.75	?
14	22 APR 82	02 11 N 140 02 W	4.75	?
14	24 APR 82	10 53 N 148 17 W	6.75	?
15	17 MAY 82	18 47 N 110 52 W	5.50	2
16	21 MAR 83	00 03 S 124 54 W	4.75	1

YELLOW-LEGGED GULL (Larus livens)

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
17	10 NOV 83	18 18 N 104 00 W	3.00	+

LAVA GULL (Larus fuliginosus)

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
12	02 JUL 81	00 26 S 090 18 W	4.50	1

FRANKLIN'S GULL (Larus pipixcan)

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
1	05 DEC 74	19 04 N 104 19 W	0.00	+
3	04 FEB 77	11 56 S 077 19 W	0.00	+
4	08 APR 78	20 33 N 105 45 W	4.50	3
12	21 JUN 81	03 58 N 083 33 W	9.75	1
13	09 NOV 81	00 06 N 086 55 W	5.50	1
13	11 NOV 81	01 06 S 081 08 W	4.50	16
13	12 NOV 81	06 13 S 081 16 W	6.75	19
13	13 NOV 81	09 52 S 078 53 W	6.25	1
13	14 NOV 81	11 59 S 077 17 W	0.75	54
13	20 NOV 81	11 51 S 077 25 W	4.50	500
13	29 NOV 81	05 09 S 081 36 W	2.25	2
14	18 MAR 82	12 02 S 077 10 W	1.25	+
14	24 MAR 82	12 03 S 077 08 W	0.75	14

FRANKLIN'S GULL (Larus pipixcan) - continued

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
15	14 JUN 82	10 46 N 109 30 W	1.25	1
16	04 FEB 83	11 54 S 077 24 W	1.00	1
17	22 NOV 83	02 00 S 108 00 W	3.25	1

GULL-BILLED TERN (Sterna nilotica)

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
2	10 FEB 79	09 26 N 084 57 W	4.50	1

CASPIAN TERN (Hydroprogne caspia)

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
5	27 FEB 79	19 04 N 104 19 W	0.00	+

COMMON TERN (Sterna hirundo)

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
1	28 NOV 74	19 09 N 104 45 W	3.00	?
4	08 APR 78	20 33 N 105 45 W	4.50	25
5	17 FEB 79	16 16 N 099 47 W	7.00	86
7	28 JAN 80	08 38 N 079 27 W	1.50	1
7	13 FEB 80	19 04 N 104 20 W	2.50	579
10	17 SEP 80	07 08 N 081 12 W	4.50	?
12	23 JUN 81	08 57 N 079 34 W	0.00	?
12	28 JUN 81	08 42 N 079 27 W	2.25	9

COMMON TERN (Sterna hirundo) - continued

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
13	08 DEC 81	06 45 N 080 15 W	7.75	4
14	24 MAR 82	12 03 S 077 08 W	0.75	?
17	10 NOV 83	18 18 N 104 00 W	3.00	?

FORSTER'S TERN (Sterna forsteri)

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
1	28 NOV 74	19 09 N 104 45 W	3.00	?

GRAY-BACKED TERN (Sterna lunata)

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
8	09 APR 80	00 01 S 149 08 W	6.50	2
8	10 APR 80	00 00 N 152 51 W	7.00	2
8	11 APR 80	00 00 N 156 15 W	7.75	23
12	28 JUN 81	08 42 N 079 27 W	2.25	?
16	12 MAR 83	17 31 S 149 48 W	0.25	5
16	14 MAR 83	14 56 S 146 45 W	3.50	1
16	21 MAR 83	00 03 S 124 54 W	4.75	1
18	09 MAR 84	17 25 S 149 45 W	0.75	?
18	15 MAR 84	18 12 S 149 43 W	5.25	2

BRIDLED TERN (Sterna anaethetus)

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
10	17 SEP 80	07 08 N 081 12 W	4.50	40
12	22 JUN 81	07 02 N 080 00 W	6.75	+
13	08 DEC 81	06 45 N 080 15 W	7.75	13
15	04 JUN 82	18 50 N 104 11 W	1.00	1
16	26 JAN 83	12 20 N 090 11 W	4.50	?

CRESTED TERN (Sterna bergii)

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
16	01 MAR 83	14 50 S 138 30 W	3.00	3
16	02 MAR 83	15 51 S 140 52 W	3.75	2
16	03 MAR 83	16 07 S 142 31 W	3.75	1
16	04 MAR 83	17 03 S 144 22 W	0.50	+
16	16 MAR 83	10 26 S 139 46 W	6.25	2
18	09 MAR 84	17 25 S 149 45 W	0.75	2
18	15 MAR 84	18 12 S 149 43 W	5.25	1

ROYAL TERN (Sterna maximus)

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
2	04 FEB 76	09 39 N 084 47 W	3.50	+
5	17 FEB 79	16 16 N 099 47 W	7.00	2
7	01 FEB 80	06 51 N 080 40 W	8.75	1
14	20 FEB 82	28 33 N 115 55 W	6.75	1
14	26 FEB 82	09 23 N 092 56 W	5.00	5
14	06 MAR 81	05 04 S 081 45 W	5.75	?

ROYAL TERN (Sterna maximus) - continued

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
15	04 JUN 82	18 50 N 104 11 W	1.00	4

ELEGANT TERN (Sterna elegans)

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
1	28 NOV 74	19 09 N 104 45 W	3.00	34
3	04 FEB 77	11 56 S 077 19 W	0.00	7
5	22 FEB 79	15 43 N 099 35 W	9.00	2
5	27 FEB 79	19 04 N 104 19 W	0.00	+
9	07 JUL 80	27 58 N 115 07 W	9.00	+
16	04 FEB 83	11 54 S 077 24 W	1.00	?

SANDWICH TERN (Sterna sandvicensis)

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
7	28 JAN 80	08 38 N 079 27 W	1.50	1
12	28 JUN 81	08 42 N 079 27 W	2.25	27

BLUE-GRAY NODDY (Procelsterna cerulea)

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
16	24 FEB 83	06 33 S 122 34 W	3.75	1
16	26 FEB 83	11 38 S 127 51 W	4.75	1
16	02 MAR 83	15 51 S 140 52 W	3.75	2
16	16 MAR 83	10 26 S 139 46 W	6.25	31

BLUE-GRAY NODDY (Procelsterna cerulea) - continued

<u>CRUISE #</u>	<u>DATE</u>	<u>NOON POSITION</u>	<u>OBSERVATION TIME(h)</u>	<u>NUMBER OBSERVED</u>
16	17 MAR 83	08 30 S 136 51 W	6.00	9
16	18 MAR 83	06 07 S 133 37 W	3.75	4
16	19 MAR 83	03 59 S 130 40 W	5.25	1
16	21 MAR 83	00 03 S 124 54 W	4.75	?
16	12 APR 83	30 23 S 116 34 W	2.00	16

